

COMMONWEALTH OF MASSACHUSETTS

Deval Patrick, Governor
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MASSACHUSETTS WEATHERIZATION ASSISTANCE PROGRAM TECHNICAL MANUAL

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Department of Housing and Community Development
Division of Community Services
Energy Conservation Unit



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The Massachusetts Weatherization Assistance Program Technical Manual is intended to be used in conjunction with the Northeast Weatherization Field Guide to provide comprehensive technical guidelines on appropriate weatherization protocols, techniques, and materials.

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US Department of Energy Weatherization Assistance Program

Mission Statement:

"To reduce heating and cooling costs for low-income families, particularly for the elderly, people with disabilities, and children, by improving the energy efficiency of their homes while ensuring their health and safety."



*Weatherization
Works*

Massachusetts Weatherization Assistance Program Technical Manual

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I. STANDARDS FOR WEATHERIZATION MATERIALS (January 1, 2011)

THERMAL INSULATING MATERIALS FOR BUILDING ELEMENTS INCLUDING WALLS, FLOORS, CEILINGS, ATTICS, AND ROOFS

<u>MATERIAL</u>	<u>STANDARDS</u>
<u>Insulation: Mineral Fiber</u>	
Blanket/Batt.	ASTM ¹ C665-06
Roof Insulation Board	ASTM C726-05
Loose-Fill.	ASTM C764-06a
<u>Insulation: Organic Fiber</u>	
Cellulosic Fiber Insulating Board.	ASTM C208-95 (2001)
Cellulose Loose-Fill.	ASTM C739-05b/CPSC HH-I-515E
<u>Insulation: Organic Cellular</u>	
Rigid Cellular Polystyrene	ASTM C578-07
Preformed Unfaced Rigid Polyurethane Insulation	ASTM C591-07
Polyurethane or Polyisocyanurate Board Faced With Aluminum Foil on Both Sides	F.S. ² HH-I-1972/1 (1981)
Polyurethane or Polyisocyanurate Board Faced With Felt on Both Sides	F.S. HH-I-1972/2 (1981)
<u>Insulation: Composite Board</u>	
Gypsum Board and Polyurethane or Polyisocyanurate Composite Board	F.S. HH-I-1972/4 (1981)
Materials Used as a Patch to Reduce Infiltration through the Building Envelope	Commercial Availability

¹ASTM indicates American Society for Testing and Materials.

²F.S. indicates Federal Specification.

**THERMAL INSULATING MATERIALS FOR PIPES, DUCTS, AND EQUIPMENT SUCH
AS BOILERS AND FURNACES**

<u>MATERIAL</u>	<u>STANDARDS</u>
<i><u>Insulation: Mineral Fiber</u></i>	
Preformed Pipe.	ASTM C547-07
Blanket Insulation (Commercial and Industrial Type)	ASTM C553-02
Blanket Insulation and Blanket Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).	ASTM C592-04
Block and Board	ASTM C612-04
High Temperature Fiber Blanket Insulation	ASTM C892-05
<i><u>Insulation: Mineral Cellular</u></i>	
Calcium Silicate Block and Pipe	ASTM C533-07
Cellular Glass.	ASTM C552-03
Molded Expanded Perlite Block and Pipe . .	ASTM C610-07
<i><u>Insulation: Organic Cellular</u></i>	
Preformed Flexible Elastomeric Cellular in Sheet and Tubular Form . . .	ASTM C534-07A
Unfaced Preformed Rigid Cellular Polyisocyanurate	ASTM C591-07

FIRE SAFETY REQUIREMENTS FOR THERMAL INSULATING MATERIALS
ACCORDING TO INSULATION USE STANDARDS

MATERIAL

STANDARDS

Attic Floor.

Insulation materials intended for exposed use in attic floors shall be capable of meeting the same smoldering combustion requirements given for cellulose insulation in ASTM C739-05b.

Enclosed Spaces

Insulation materials intended for use within enclosed stud or joist spaces shall be capable of meeting the smoldering combustion requirements given for cellulose insulation in ASTM C739-05b.

Exposed Interior
Walls & Ceilings

Insulation materials, including those with combustible facings, which remain exposed and serve as wall or ceiling interior finish shall have a flame spread classification not to exceed 150 (per ASTM E84-06a).

Exterior Envelope Walls
and Roofs

Exterior envelope walls and roofs containing thermal insulation shall meet applicable local government building code requirements for the complete wall or roof assembly.

Pipes, Ducts, and Equipment

Insulation materials intended for use on pipes, ducts, and equipment shall be capable of meeting a flame spread classification not to exceed 150 (per ASTM E84-07).

WINDOW SYSTEMS

MATERIAL

STANDARDS

Moveable Insulation Systems for
Windows (Quilts)

Commercial Availability

Interior Storm Windows and
Deadlights.

A demonstrated ten (10) year effective life expectancy with a solid glazing panel, rigid frame and either fixed in place or securely installed with permanent hardware.

REPLACEMENT WINDOWS

MATERIAL

STANDARDS

Replacement Windows

Aluminum Frame.	ANSI/AAMA/NWWDA 101/I.S. 2-97 Energy Star Rated for the Northern Climate Zone
Steel Frame	Steel Window Institute Recommendation Specifications for Steel Windows, 1990 Energy Star Rated for the Northern Climate Zone
Wood Frame.	NSI/ AAMA/ NWWDA 101/ I.S.2-97. Energy Star Rated for the Northern Climate Zone
Rigid Vinyl Frame.....	ANSI/AAMA/NWWDA 101/I.S. 2-97 Energy Star Rated for the Northern Climate Zone

NOTE: *Sealed, insulated glass units shall be warranted against failure of the seal for a period of at least ten (10) years.*

REPLACEMENT DOORS

MATERIAL

STANDARDS

Hinged Replacement Doors

Steel	ANSI A250.8-98
Wood:	
Flush	Exterior door provisions of ANSI/ NWWDA I.S. 1-97
Pine, Fir, Hemlock, Spruce. . .	ANSI/ NWWDA I.S. 6-97

Sliding Glass Replacement Doors

Aluminum.	ANSI/ AAMA/ NWWDA 101/I.S 2-97
Wood.	ANSI/ AAMA/ NWWDA 101/I.S 2-97

CAULKS AND SEALANTS

MATERIAL

STANDARDS

Caulks and Sealants	Minimum 20-year life
High Temperature Caulk (Heat Producing Sources, Chimney Surround, etc.)...	ASTM E-136
Glazing Compound	ASTM C669-00 (Withdrawn 2002)
Oil and Resin Base Caulks	ASTM C570-00 (Withdrawn 2002)
Acrylic (Solvent- type) Sealants	ASTM C920-05
Butyl Rubber Sealants	F.S. Commercial Item Description A-A-272 (6/7/95)
Latex Sealing	ASTM C834-05
Elastomeric Joint Sealants (Normally considered to include polysulfide, polyurethane, and silicone).	ASTM C920-05
Elastomeric Cellular Preformed Gasket And Sealing Materials	ASTM C509-06
Backer Rod, Oakum, Untreated Jute, Natural Fiber Twine, Synthetic Twine, or other suitable material	Commercial availability
Duct Sealing Materials	Pressure Sensitive or Heat Activated Tape or Mastic. Conformance to U.L. 181A or 181B

COMPACT FLUORESCENT LIGHT BULBS

MATERIAL

STANDARDS

CFLs.....	UL and an electric utility approved product
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WEATHERSTRIPPING

MATERIAL

Weatherstripping.

STANDARDS

Must be permanently installed with fasteners (screws, nails, staples, etc.) and must have a demonstrated life expectancy of at least ten (10) years. All V-strip weatherstripping must be of the pre-molded type with an effective memory.

VAPOR RETARDERS

MATERIAL

Vapor Retarders.

STANDARDS

Selected according to the provisions cited in ASTM C755-03; permeance not greater than 1 perm when determined according to the desiccant method described in ASTM E96-00.

Items to Improve Attic Ventilation. . . .

Commercially available

SKIRTING

MATERIAL

Skirting.

STANDARDS

Commercially available

AUTOMATIC SETBACK THERMOSTATS

MATERIAL

Automatic Setback Thermostats.....

STANDARDS

Listed by U.L. Conformance to NEMA⁵ DC 3-2003

⁵ NEMA indicates National Electrical Manufacturers Association

BOILER / FURNACE CONTROL SYSTEMS

MATERIAL

STANDARDS

Automatic Set-Back Thermostats.	Listed by U.L. Conformance to NEMA DC3-2003
Line Voltage or Low Voltage Room Thermostats	Listed by U.L. Conformance to NEMA DC3-2003
Hydronic Boiler Controls	Listed by U.L.
Energy Management Systems	Listed by U.L.
Other Burner Controls	Listed by U.L.

WATER HEATER MODIFICATIONS

MATERIAL

STANDARDS

Distribution Piping.	(See Insulation Standards)
Hot Water Pipe Heater Strips	Listed by U.L.
Reduce Thermostat Settings	Set Back to 130°
Install Vent Damper, Gas Fueled	ANSI Z21.66-1996, including Exhibits A and B ANSI Z223.1-2002
Low Flow Water Faucet Aerators	Commercially available. Brass, Chrome-plated.
Low Flow Shower Heads	ANSI/ ASME A112.18.1. Not to exceed 2.5 Gallons per Minute (GPM).

BOILER REPAIR AND MODIFICATIONS/ EFFICIENCY IMPROVEMENTS

MATERIAL

STANDARDS

Replacement Oil Burners	527 CMR Oil Burning Equipment Board of Fire Prevention and NFPA 31-2001.
Gas Power Burners	ANSI Z223.1 2002
Furnaces, Oil	U.L. 727, Eighth Edition, 1994 and NFPA 31-2001. Minimum AFUE 83%
Furnaces, Gas	ANSI Z21.47-1998 and ANSI Z223.1-2002 (same as NFPA 54-1999). Minimum AFUE of 90%.

Hot Water Boilers	Minimum AFUE of 85%
Steam Boilers.....	Minimum AFUE of 82%
Cleanout/Tune-Up.	Per HEARTWAP Guidance
Combustion Chambers	NFPA 31-2001
Thermostatic Radiator Valves.	Commercially available. One-pipe steam systems require air vents on each radiator; see manufacturers' requirements.

II. HEALTH and SAFETY

MASSACHUSETTS WEATHERIZATION ASSISTANCE PROGRAM

HEALTH AND SAFETY GUIDANCE

The health and safety of clients, subgrantee staff and contractors is of primary concern to the Department of Housing and Community Development. It is important that all personnel maintain a high level of awareness concerning the potential hazards associated with the weatherization process.

The standards set forth in this guidance provide only general guidelines for health and safety concerns. Subgrantee staff and contractors must familiarize themselves with all the health and safety issues associated with weatherization. More specific information concerning indoor air quality problems can be obtained through the Federal Environmental Protection Agency (EPA) and the U.S. Consumer Product Safety Commission. Detailed specifications regarding the health and safety of workers in the construction industry can be found in the Occupational Safety and Health Administration's (OSHA) 29 CFR Parts 1910 and 1926, "Standards Improvement (Miscellaneous Changes) For General Industry and Construction Standards." These standards are applicable to all workers providing services using funding under the WAP program.

Weatherization funds may be obligated to correct Health and Safety problems in client homes. According to DOE regulations, these funds may be used only for the "elimination of energy related health and safety hazards which are necessary before or because of the installation of weatherization materials." Further restrictions on the expenditure of Weatherization funds are outlined in this Guidance. Subgrantees may spend up to \$2,500 inclusive of all other incidental repairs for health and safety on an individual dwelling unit with an average of \$500 per unit for the entire grant. Health and safety expenses must be reported in the appropriate cost category on the Building Weatherization Report (BWR). Health and Safety costs must be tracked separately and reported in the appropriate category in the DOE WAP Monthly Report.

Each home weatherized by the WAP must be individually assessed to determine the existence of potential hazards to workers or clients. If unsafe conditions exist that would endanger the health or safety of the clients or weatherization workers, and those conditions cannot be corrected, no WAP work may be started on that home.

Client and worker education may be the most important tool in dealing with health and safety concerns in the Weatherization Program. Educated clients and workers are far more likely to conduct themselves in a manner that is consistent with program goals.

WORKERS: The Department of Housing and Community Development allows technical waivers for non-performance of audits, installations and/or inspections, or any portion of these functions, if such action will expose workers to conditions regarded as unsafe or unhealthy as determined by OSHA Construction Industry Standards. **All WAP Technical staff and contractors working in the Massachusetts WAP are strongly encouraged to attend the OSHA 10 Hour Construction Safety Course.**

Each worker is responsible for working in a safe manner so as to not endanger either himself or others. Individuals who continue to demonstrate that they are unable to work in a safe, professional manner will not be retained by the program.

CLIENTS: Subgrantees and their representatives are required to take all reasonable precautions against performing work on homes that will subject clients to health and safety risks. During the energy audit process, the energy auditor will make an evaluation of the individual health of the home's occupants. In cases where a person's health is fragile and/or the weatherization activities would

constitute a health or safety hazard, the occupants will be required to leave during the work process or the agency and contractor should not begin the work. Work that is completed should in no way contribute to or create an unhealthy condition in the home. All problems and concerns must be fully documented in the client file.

Indoor Air Quality and Environmental Concerns

Weatherization activities can have a significant effect on how a home works. As building tightness increases and the infiltration rate decreases, air quality problems can become an unintentional consequence. Low concentrations of pollutants or water vapor may become higher, potentially dangerous concentrations. Combustion and venting characteristics of combustion appliances may be affected, causing the release of unhealthy combustion by-products into the living space. It is crucial that the agency inspector be aware of the interactions between building tightness and potential indoor air quality problems. Ductwork leakage will play a role in this whole formula. An important part of the initial inspection of the home must be a thorough evaluation of potential indoor air quality problems.

The initial inspection must include the following:

- Blower door testing consistent with the WAP Technical Manual.
- Carbon monoxide (CO) testing of all combustion appliances.
- Evaluation of the venting system of all vented appliances including backdraft testing.
- A complete evaluation of existing and potential moisture and mold related problems throughout the dwelling.
- A determination of the existence of any one of a number of hazardous substances (asbestos, lead paint, volatile organic compounds) that may be stored in the home.

If there are existing problems, work must not commence until steps are taken to mitigate the problems.

To ensure that the completed WAP work does not create potential problems, each Quality Control visit must include:

- A final blower door test after all work has been completed. This test must be consistent with the WAP Technical Manual to ensure that building tightness recommendations have not been exceeded.
- A carbon monoxide test of all combustion appliances.
- A thorough evaluation of the venting characteristics of all combustion appliances, including testing for spillage and backdrafting.
- An evaluation of the moisture and mold conditions in the living space, attic and basement.

If the final Quality Control inspection indicates that a problem exists, the agency must correct the problem prior to submitting the unit as a completion.

Potential Health and Safety Risks Associated with Weatherization

Following is an overview of some of the potential health and safety risks that may be associated with home weatherization and suggested approaches to minimize exposure.

Asbestos

Description: Fibrous, non-combustible mineral that has been used commonly in a variety of building construction materials for insulation and as a fire-retardant.

Health/Safety Concerns: Asbestos fibers are microscopic. When disturbed and released into the air, the fibers can be inhaled. Significant exposure may result in lung cancer, asbestosis or mesothelioma.

Sources in Homes: Until its use was strictly limited in the 1970's, asbestos was used in a large number of building products. The most common applications that could involve interaction with weatherization personnel include:

- boiler insulation,
- furnace insulation,
- pipe insulation,
- duct insulation,
- vermiculite insulation, and
- asbestos cement sidewall shingles.

Workers may encounter asbestos in plaster, joint compound, sidewall and roof shingles, floor tiles and other building products, particularly when these items are disturbed.

To minimize asbestos exposure:

- Learn to recognize suspected asbestos containing materials.
- Avoid disturbing friable Asbestos Containing Materials (ACM). Friable asbestos is "any material containing greater than one percent asbestos by weight or volume that hand pressure can crumble, pulverize or reduce to powder when dry, or any asbestos containing materials that can reasonably be expected, as a result of the demolition or renovation to be undertaken, to become pulverized through breaking, chipping, crumbling, crushing, or other means of rendering fibers available to the ambient air."
- **NEVER CONDUCT A BLOWER DOOR TEST ON A BUILDING WHERE FRIABLE ASBESTOS IS PRESENT.**
- Provide information to clients regarding the existence of suspected ACM and provide client education advising non-disturbance of such materials.
- When asbestos cement sidewall shingles are removed and reinstalled as part of a wall insulation procedure, the contractor must complete the work in compliance with the DHCD/Mass DEP Asbestos Cement Shingle Guidance in the Massachusetts DOE WAP Technical Manual.

WAP funds may not be used to complete asbestos abatement work unless extreme mitigating factors exist and DHCD's prior approval is granted for health and safety reasons. Asbestos abatement can be completed as part of a heating system replacement consistent with the "Asbestos Abatement Guidance" of the HEARTWAP Program Guidance and paid for with HEARTWAP funds.

This information is general program guidance for Weatherization personnel and does not provide the detailed specifications for the proper handling of ACM. State law concerning asbestos abatement can be found in the Commonwealth of MA Department of Public Health's asbestos abatement regulation: 105 CMR 410.353.

Lead

Description: Lead is a poisonous metal that can damage the human nervous system (especially in young children) and cause blood and brain disorders. It is contained in paint and various other substances.

Health/Safety Concerns : Ingestion or absorption of lead into the blood stream is a serious health hazard causing brain damage over a period of time. This can be a particularly serious problem with small children, who may ingest paint chips or flakes, or dust contaminated with lead products. Serious learning disabilities can result from excessive lead levels in the bloodstream. Workers can be contaminated in the same way as children, but are most likely to be exposed by breathing dust contaminated by sanding or planing surfaces that contain lead based paints.

Sources in Homes : Lead paint is the primary source of lead in a home. Contamination occurs when lead paint is disturbed by sanding, chipping, or flaking. Lead is also present in the solder used in plumbing pipe joints. Lead can leach into potable water, particularly when water is stagnant in the pipes for a length of time. To a lesser degree, lead contamination can result from inks used in newspapers and magazines.

To minimize risks to clients and Weatherization personnel:

- **Do not disturb lead paint unless absolutely necessary. When lead paint may be disturbed, all work must be completed by Certified Renovators consistent with the procedures and protocols required by the U.S. Environmental Protection Agency's (EPA's) "Lead Paint: Renovation, Repair, and Painting Program (RRP)".** Subgrantees must assume that any paint on windows and doors in homes built before 1978 contains lead unless it has been verified otherwise.
- **Household notification requirements:** Prior to beginning renovation, repairs, and painting in pre-1978 housing and child-occupied facilities subgrantees must provide the occupants with, "*Renovate Right Important Lead Hazard Information for Families, Child Care Providers and Schools*" developed by the US Environment Protection Agency (EPA) and the US Department of Housing and Urban Development (HUD). Weatherization work falls under this requirement. Subgrantees must collect documentation from the contractor that the client received the pamphlet. The EPA pre-renovation disclosure form included in the pamphlet may be used for this purpose. The signed form must be maintained as a part of the record for that project. The pamphlet can be accessed here:
(<http://www.epa.gov/lead/pubs/renovaterightbrochure.pdf>)
- **All weatherization work that may disturb lead-based paint in pre-1978 homes must be completed by EPA Certified Firms using Certified Renovators.** Effective 7/13/2010 administrative and enforcement of the EPA RRP was taken over by the Massachusetts Executive Office of Labor and Workforce Development, Division of Occupational Safety (MA DOS). EPA Certified Firms must apply to the MA DOS for a Contractor License Waiver. Companies not certified as of that date must apply for a Massachusetts License. All work practices must be consistent with the requirements of the MA DOS RRP. Examples of Lead-safe practices include (but are not limited to):
 - Work area containment to prevent dust and debris from leaving the work area. The containment requirements vary depending on the activities conducted and location of the work. Work on the exterior of the building has additional containment requirements.
 - The prohibition of certain work practices like open face burning and the use of power tools without HEPA exhaust control.
 - Thorough clean-up followed by a verification procedure to minimize exposure to lead-based paint hazards.

The MA DOS RRP training and certification process for renovators and firms requires many specific protocols for when the RRP requirements must be met and what work practices are required depending upon individual circumstances. The EPA's "*Small Entity Compliance Guide to Renovate Right, EPA's Lead-Based Paint Renovation, Repair and Painting Program*" provides simplified guidance of how and when these regulations

apply. The brochure can be accessed here: <http://www.epa.gov/lead/pubs/sbcomplianceguide.pdf>. Information regarding Massachusetts specific requirements can be accessed at the MA DOS website.

Additional detailed specifications regarding the health and safety of workers in the construction industry can be found in Construction Industry OSHA Safety and Health Standards (29 CFR 1926/1910) and the specific worker safety requirements in the EPA's "Lead: Renovation, Repair, and Painting Program" (LRRPP) Final Rule. See also Section 5.13 *Lead- Safe Weatherization* within the Northeast Weatherization Field Guide.

Generalized lead paint removal is not an allowable activity under the Weatherization Assistance Program. The information in this guidance is not intended to provide specific information for the proper handling of lead. For detailed information regarding lead paint abatement see Commonwealth of Massachusetts' Publications 454 CMR 22.00 and 460 CMR.

In addition to the EPA Lead Paint RRP program, the U.S. Department of Energy requires that Lead Safe Weatherization practices be conducted at all times when there is a possibility of disturbing lead paint in a home being weatherized.

DOE LEAD SAFE WEATHERIZATION INFORMATION

Lead Safe Weatherization (LSW) is defined by the U.S. Department of Energy (DOE) as a set of techniques designed to: minimize the production of lead paint dust and chips, prevent the spread of dust and chips, and to include a thorough cleaning of the work area once the work is completed.

U.S. Department of Energy's Policy Regarding Lead-Based Paint in Homes

Lead-based paint dust and other residues are hazards that Weatherization workers are likely to encounter in older homes. HUD estimates that four million homes have significant lead-based paint hazards. Furthermore, Weatherization work may directly disturb lead-based paint, possibly creating hazardous conditions. While the authorizing legislation for DOE's Weatherization Assistance Program (WAP) does not specifically address lead-based paint hazard reduction, DOE's policy is that Weatherization workers must be aware of the hazard and conduct Weatherization activities in a safe work manner to avoid contaminating homes with lead-based paint dust and debris, and to avoid exposing themselves and their families to this hazard.

It is important to remember that WAP's legislated purpose is to install energy efficiency measures in weatherization client's homes in order to lessen their energy cost burden. WAP is not funded to do lead-based paint abatement work, or to do lead-based paint hazard control or stabilization. In the process of weatherizing a home, workers sometimes encounter and have to disturb painted surfaces that are known or presumed to contain lead-based paint. When that happens, DOE funds may be used to minimize the potential hazard associated with the specific painted surfaces that workers are directly disturbing in the course of installing an energy efficiency measure, but DOE funds may not otherwise be used for abatement, stabilization, or control of the lead-based paint hazard that is in the house.

Post-Weatherization Cleanup

Cleanup at the completion of Lead-Safe Weatherization work requires the use of a HEPA vacuum, (a HEPA filter in a standard vacuum is NOT an acceptable alternative) wet cleaning methods, a visual inspection and the collection and disposition of any dust, debris or chips with the rest of the jobsite waste.

Pollution Occurrence Insurance Coverage

The U.S. Department of Energy has recommended that all WAP Subgrantees procure Pollution Occurrence Insurance Coverage (POI) to protect against incurred liability due to lead-dust disturbance. DOE has stated that "adequate liability" must exist and has determined that most general liability policies are inadequate in the areas of pollution occurrence due to industry exemptions. Massachusetts requires WAP Subgrantees to

maintain a POI policy adequate to protect against potential incurred liability. Verification of this coverage is completed annually.

U.S. Department of Energy's Minimum Standards for Lead Safe Weatherization (LSW)

Safe work practices must be implemented to minimize exposure to hazards for the customer and the workers, while allowing Weatherization to occur in a cost-effective manner and to not hinder production. The effort required will be based on the hazard, the work specifications, and customer health issues.

CHECK Federal, state, and local regulations.

- OSHA has rules for worker safety.
- States and local communities may have rules for waste disposal.

To meet the LSW minimum standards, crews and contractors MUST follow the general principles of working clean and working wet. Best practices for working clean and working wet are available in the benchmark LSW procedures and curriculum and should be reviewed and consistently enforced on LSW jobs.

A. Requirements

1. Weatherization Worker Protection

LSW includes these procedures and safety precautions:

- Wear personal protective gear specifically suited for the particular LSW measure. Use at least ½ face respirators with HEPA filters that are approved by the National Institute for Occupational Safety and Health (NIOSH).
- Use disposable overalls (with hood or a disposable painter's cap), gloves (cloth, plastic, or rubber as appropriate), goggles, and disposable shoe/boot covers.
- Keep dust to a minimum and confine dust and paint chips to the work area.
- Clean up area during and after work.
- During Weatherization, wash your hands and face frequently, particularly when leaving the work area and especially before leaving the area for the purpose of eating, drinking, or smoking.
- Before leaving a confined work area, remove your protective clothing and protective shoe/boot covers to avoid exposing others.
- Before leaving a confined work area, and before returning tools and equipment to vehicles, clean all tools to avoid exposing others and creating a lead-hazard to the next Weatherization job.
- Get annual medical exams to check blood lead levels. Do non-lead-related work if your blood lead level gets too high.
- Inform your employer if you develop signs of lead poisoning.

2. Client Notification

Consistent with the EPA and MA DOS RRP Program subgrantees must provide occupants of the home the EPA brochure, Renovate Right Important Lead Hazard Information for Families, Child Care Providers and Schools. A copy of the signed acknowledgement must be included in the client file.

For occupied homes, the Weatherization staff, crew, or contractor must have an adult tenant or homeowner sign an acknowledgement after receiving the pamphlet. The pamphlet can also be sent by certified mail with receipt to be placed in the client file.

In multi-unit housing, the agency must:

- Provide written notice to each affected unit (notice must describe: general nature and locations of the planned renovation activities; the expected starting and ending dates; statement of how occupant can get

- pamphlet at no charge); or
- Post informational signs (signs must describe general nature and locations of the renovation and the anticipated completion date) and post the EPA pamphlet. (If pamphlet is not posted then agencies are required to provide information on how interested occupants can review a copy of the pamphlet or obtain a copy at no cost from the Weatherization Program).
- Delivery to owner/occupant. Owner's and/or occupant's signature with acknowledgment or certificate of mailing. The owner/occupant must acknowledge receipt of the EPA pamphlet prior to start of renovation that contains the address of unit undergoing renovation, name and signature of owner or occupant, and the date of signature. It must be in same language as "contract for renovation" for an owner-occupied (or the same language as the lease for occupant of non-owner occupied) target housing.

If the subgrantee cannot get a signed acknowledgment (either the occupant is not home or refuses to sign the form), then the self-certification section of the form must be signed to prove delivery.

The acknowledgement form must be filed and remain with the client file for three years from date of signature. In addition to providing a copy of the pamphlet to owners and occupants, the subgrantee and or weatherization contractor must discuss the hazards associated with lead-based paint and lead dust, and describe how they will conduct LSW in the home.

B. General LSW Work Practice Standards

- Crews and contractors must take steps to protect occupants from lead-based paint hazards while the work is in-progress using appropriate containment strategies.
- Occupants, especially young children or pregnant women, may not enter the work site. Occupants are allowed to return only after the work is done and the home has passed a visual inspection.
- Occupants' belongings must be protected from lead contamination. This can be done by removing them from the work area or covering them in protective bags and sealing it to prevent dust from getting on the items.
- The work site must be set up to prevent the spread of leaded dust and debris.
- Warning signs must be posted at entrances to the worksite when occupants are present; at the main and secondary entrances to the building; and at exterior work sites. The signs must be readable from 20 feet from the edge of the worksite. Signs should be in the occupants' primary language, when practical.
- The work area must be contained. If containment can not be achieved with occupants in the unit (e.g., work will take several days and involves the kitchen, bathrooms, or bedrooms that can not be sealed off from use), occupants must move out of the unit or the work must be deferred until containment can be achieved.
- A Certified Renovator must supervise and inspect Weatherization work of any type and scale to ensure it is being done properly.
- Ensure containment does not interfere with occupant and worker egress in an emergency.

C. Containment

Containment is anything that stops any dust or debris from spreading beyond the work area to non-work areas. The level of containment must be determined by the auditor/inspector or supervisor before work is assigned to a crew or contractor.

- NEVER - allow residents and pets access to the work area while work is underway.
- NEVER - open windows and doors allowing lead dust to float into other parts of the building or outside.
- NEVER - allow furniture and other objects to remain in the Weatherization work area while Weatherization work is being performed unless they are covered and sealed in polyethylene sheeting or bags.

Every home and every specific Weatherization measure is unique; therefore the level of containment required will be based on the hazards present, the age of the home, the scope of work activities, and any customer health issues.

Although Weatherization jobs require individual assessments, LSW work generally falls into two levels of containment and the related standards are outlined below.

Level 1 Containment

Level 1 Containment is required in pre-1978 homes when less than 6 square feet of interior painted surface per room or 20 square feet of exterior painted surface will be disturbed.

Level 1 Containment consists of methods that prevent dust generation and contains all debris generated during the work process. The containment establishes the work area which must be kept secure.

Measures requiring Level 1 Containment may include:

- Installing or replacing a thermostat
- Drilling and patching test holes
- Replacing HEPA filters and cleaning HEP A vacuums
- Changing Furnace Filter
- Removing caulk or window putty (interior)
- Removing caulk or window putty (exterior)
- Removing weather-stripping

Level 2 Containment

Level 2 Containment is required when Weatherization activities will disturb more than 6 square feet of interior surface per room or 20 square feet of exterior surfaces in homes built prior to 1978. Level 2 containment consists of methods that define a work area that will not allow any dust or debris from work area to spread. Level 2 Containment requires the covering of all horizontal surfaces, constructing barrier walls, sealing doorways, covering HVAC registers with approved materials, and closing windows to prevent the spread of dust and debris.

Measures requiring Level 2 Containment may include:

- Drilling holes in interior walls
- Drilling holes in exterior walls, removing painted siding
- Cutting attic access into ceiling or knee walls
- Planing a door in place
- Replacing door jambs and thresholds
- Replacing windows or doors
- Furnace replacements

Additionally, Level 2 containment must ALWAYS be used where any of the following is conducted (even if the activities will disturb less than the hazard de minimis levels within the Level 1 category):

- Window replacement
- Demolition of painted surface areas

D. Proper LSW Clean-Up and Debris Disposal

Following the containment standards in the previous section will minimize the level of effort required to properly clean up the job site. All dust, dirt, material scraps, containers, wrappers, and work related debris must be removed from the customer's home. A HEPA vacuum should be used to clean up the work areas. Further cleaning may be necessary based on the hazard.

At the conclusion of the job, once all workers have "cleaned" the work areas thoroughly, Weatherization workers must adhere to the following:

- Safe and Secure Disposal

- Bag and gooseneck-seal all waste in 6-mil. plastic bags.
- Safely dispose of all waste in accordance with federal, state, and local regulations.

- Visual Inspection Verification:

Checking the quality of worksite cleanliness is a two-phase process:

- Phase 1: Worker visual inspection during the cleaning process; look for any visible paint chips, dust, or debris as you clean, using proper techniques.
- Phase 2: Supervisor visual inspection after cleanup. There should be no evidence of settled dust following a cleanup effort. If dust is observed, the Weatherization crew must be required to repeat the cleaning.

If work is done outside the house, the grounds around the dwelling and all exterior horizontal surfaces should also be examined visually to make certain that all waste and debris have been removed and that paint chips were not left behind. To comply with EPA's RPP Rule, cleaning verification using EPA-developed cards are required. Specific steps required of the Certified Renovator during the cleaning verification process are available in the EPA's RPP Rule.

Combustion Systems

Definition: Combustion systems are fuel burning appliances used for water and/or space heating.

Health/Safety Concerns:

- Combustion of surrounding materials resulting from unsafe operation of the heating system.
- Release of unhealthy combustion products into the home environment due to a cracked heat exchanger, improper venting, spillage, or back-drafting of the appliance. Many combustion byproducts have significant adverse health effects. Some of these byproducts include carbon monoxide, carbon dioxide, nitrogen dioxide, sulfur dioxide, and particulate matter. Each byproduct may have specific health related problems depending on the concentration.
- Health hazards resulting from dysfunctional heating system (no heat).
- Gas leaks - risk of contamination of house air or explosion.
- Scalding due to water temperature set too high.

To minimize risks:

- Provide proper clearances, as required by the appropriate building code, between combustible materials and wood/coal stoves, kerosene heaters, furnaces, boilers, water heaters and flues. The National Fire Prevention Association's *Manual on Clearances for Heat Producing Appliances* provides a listing of minimum clearances for most combustion appliances.

- If there is an unvented combustion space heater being used in the building, agency policy must be to decline providing weatherization services until the client signs an agreement that the heater will be removed from the dwelling and will not be used after the work has been completed.
- Be certain that all heating appliances and water heaters have an adequate venting system, sufficient draft, no spillage of combustion products, and no back-drafting when all exhaust fans are running. Test for carbon monoxide before and after Weatherization and service all appliances that exhibit more than 100 ppm in the combustion products. **All homes with vented appliances must receive a “Worst Case Backdraft Test” of vented appliances after all work is completed.** Agency staff must be certain that the air handler of forced warm air furnaces is not contributing to back-drafting problems. If the test demonstrates a backdraft problem, the agency must take the necessary steps to rectify the situation. The results of the test and/or the resolution of any problems must be documented in the client file.
- **Agency staff must test the ambient air around combustion appliances, including gas ranges, for carbon monoxide after about 5-10 minutes of operation.** Any that create CO levels in excess of 9 ppm in the ambient air must be serviced. Ambient air should be tested in an area around the combustion appliance where a client is likely to be standing.
- Insure that the furnace heat exchanger is not cracked.
- Provide adequate combustion air for all combustion systems.
- For wood and coal stoves, provide a clean chimney. For any unvented space heating appliances, provide client education regarding the health and safety hazards associated with the operation of such equipment, and do not start any weatherization work in homes with improperly vented heating equipment until the problems are corrected.
- Check for and repair all gas leaks.
- Turn down the water heater temperature when necessary.

WAP *Repair* and/or *Health and Safety Repair* funds may be used to correct problems in combustion appliances including water heaters and dryers. Problems with space heating appliances may be referred to the HEARTWAP Program, provided that the required work can be completed before the WAP work begins.

Carbon Monoxide (CO)

Definition:

Carbon monoxide is a product of incomplete (poor) combustion. It is a direct and cumulative poison. When combined with blood hemoglobin, CO replaces oxygen in the blood until it completely overcomes the body.

Health/ Safety Concerns :

While carbon monoxide (CO) is a by-product of combustion systems, and as such was addressed in the previous section of this guidance on combustion systems, the potential for serious injury and death from this gas warrants that it is addressed separately in this Guidance.

Low level CO poisoning symptoms include: headaches, confusion, dizziness, nausea, vomiting, convulsions, sleepiness, stinging eyes, and loss of muscular control. The victim inhaling the toxic concentration of the gas may become helpless before realizing that danger exists and death from CO poisoning occurs suddenly.

The effects of low level Carbon Monoxide poisoning are cumulative. Effects can vary significantly based on age, sex, weight, and overall state of health. Children, the elderly, and the infirm may be seriously affected by even low levels of CO depending on the concentration and exposure period.

To minimize risks of CO exposure:

- Provide for the proper ventilation of all combustion appliances.
- Test for spillage, backdrafting, and CO levels of all combustion appliances prior to beginning and upon completion of all WAP jobs. To ensure the safety of the occupants, DHCD has set a maximum CO level in flue gas products of 100 ppm. The maximum allowable CO level in ambient air surrounding an appliance is 9 ppm.
- Provide any required service of combustion appliances that exhibit high levels of CO in flue gases or ambient air.
- Test the operation of all gas-fired cook stoves and ovens after 5-10 minutes of operation. Ambient air CO readings near the range should not exceed 9 ppm.
- Inform clients if a CO problem exists and recommend a temporary action to ensure client safety until the offending appliance can be serviced. If there is a significant ambient air CO problem, the subgrantee auditor should assist the occupants and contact the appropriate authorities, typically the local fire department. Conduct no weatherization activities that will tighten the home until it can be verified that the CO problem was resolved.

Other Air Quality Concerns (Biologicals, Radon, etc.)

In addition to asbestos, lead, and combustion systems, there are a number of other indoor air pollutants in homes that may present health risks to clients. Awareness of indoor air pollutants and attention on the part of weatherization personnel to the level of air-tightening measures performed on a home will aid in the prevention of making a potentially bad situation worse. Blower door testing provides important information about air leakage levels in homes. Weatherization personnel also must be aware of mechanisms by which pollutants may enter the living space.

- A. **Biologicals:** Molds, mildews, and spores, primarily caused by excessive moisture levels in a home. These substances can be a significant contributing factor in a number of health problems. Excessive moisture or standing water in a home provides an environment that allows molds and mildews to flourish. **Homes with potential moisture or identified mold problems MUST NOT be tightened until measures are taken to mitigate the problems.**
- B. **Radon:** An odorless, colorless gas that occurs naturally in the earth's crust. Long-term exposure to elevated levels may cause lung cancer. Radon mitigation is not an allowable activity under the WAP. In homes where there is an existing identified radon problem, work that would exacerbate this problem must be limited.
- C. **Volatile Organic Compounds (VOC):** Cleaning fluids, paints, solvents, herbicides, pesticides, and formaldehyde. VOCs are known to be potential irritants to lungs, eyes, and skin. Some VOCs may be carcinogenic and are frequently stored under sinks, in closets, and basements. Formaldehyde may be found in a variety of building components including plywood, carpeting, and particleboards. Recommend to clients that they move potentially dangerous materials outside into sheds or garages outside the living space or any other areas that may interact with the living space. Basements are not recommended for storage of VOCs.

- D. Airborne Particulate Matter:** Airborne particulate matter, primarily tobacco smoke or smoke from improperly vented wood stoves is known to cause respiratory problems and potentially lung cancer. Reduction in infiltration rate through weatherization may increase the concentration of the airborne particulate matter. Homes with high levels of tobacco smoke or other indoor pollutants should not be over tightened.
- E. Vermiculite Insulation:** Vermiculite insulation may found in attics and sidewalls of older homes. Vermiculite is a naturally occurring mineral that when heated to a high temperature the mineral expanded and produced a lightweight fire resistant material with good insulation properties. The mine that produced 70% of the vermiculite insulation in the United States also contained asbestos. Much of the vermiculite from that mine was contaminated with asbestos.
- E. Fiberglass:** Fibrous glass insulation material. Fiberglass is known to be an irritant to lungs, eyes and skin. Most preliminary research indicates no long-term negative health effects resulting from exposure to high levels of fiberglass, but some studies have indicated that some types of finely chopped blown-in fiberglass may be a potential carcinogen. Exposed fiberglass should not be left in occupied areas of homes. Workers are advised to wear properly rated respirators and protective clothing when working with or around fiberglass.

To minimize risks associated with indoor air pollutants:

- The initial inspection of the home must include a thorough mold and moisture assessment, inspection and documentation of existing problems. Existing mold and/or moisture problems will very likely worsen if the home is tightened and inadequate steps are taken to address the problem. If mold problems exist, weatherization must not proceed until the problem is resolved. Subgrantees must use the deferral of services policy outlined in this guidance in these instances.
- Look for and identify potential moisture problems. Determine the sources of the moisture. In the living space look for evidence of condensation on windows and walls, (stains and/or mold and mildew) especially in areas with limited air circulation. In the basement/crawlspace check for standing water, open sumps, dirt floors, leaking pipes and drains and water stains on the foundation walls. In attic spaces look for staining on the roof sheathing and rusted or frost-covered roofing nails. Note if staining is consistent through the whole attic space or localized. Potential sources of excessive moisture levels in a home include:
 - Dirt crawlspaces with no vapor barrier; standing water in the basement or crawlspace; unvented (or defective) combustion appliances; unvented clothes dryers; firewood stored in the basement or living space; excessive house plants; large number of inhabitants in small living space; defective plumbing; defective or non-existent gutters and downspouts; high ground water tables; standing water in basement or crawlspace; leaking roofs; windows; and sidewalls.
- Provide client education and materials concerning indoor air quality issues. Inform clients about potentially dangerous materials being stored in the home, as well as the problems associated with excessive moisture and mold. Document the problems with digital pictures. Recommend solutions.
- Identify all potential sources of indoor pollutants and eliminate, mitigate or ventilate at the source to the greatest degree possible. In many cases, a properly installed, vented bath or kitchen fan with an appropriate control may be adequate to meet the ventilation requirements of a home, unless underlying moisture and standing water issues exist.
- Take pre- and post-weatherization blower door tests, determine air leakage rates, and avoid over tightening homes, especially those with potential indoor air quality problems.

- Control ductwork leakage that may introduce pollutants into the living space. Leaking return ductwork can be a major problem since it can create high negative air pressure in the leak area, pull back in whatever pollutants may be in the area surrounding the ductwork, and then distribute the pollutants throughout the house. Additionally, the negative pressures of leaky returns can cause backdrafting of combustion appliances and may also introduce radon gas into basement areas.

Electric Wiring

Wiring-related safety concerns:

- Electric shock while working around wiring in all areas of homes.
- Fire resulting from arcing between loose wiring connections.
- Fire resulting from lack of dissipation of heat due to insulation around heat producing sources (i.e. recessed light fixtures).
- Integrity and safety of Knob and Tube wiring.

To Minimize Risk:

- Workers must demonstrate caution when working around wiring.
- Verify proper wiring connections and proper fusing.
- Verify proper blocking out of insulation around heat producing sources.
- A Massachusetts licensed electrician must inspect and provide a detailed written report about the condition and location of active and inactive knob and tube wiring in the client's home prior to any insulation work is started. All insulation work must be done in a manner consistent with the DHCD policy outlined below.

Knob and Tube Wiring Protocol

Subgrantees and contractors are prohibited from installing any type of insulation within 3 inches of active Knob and Tube wiring (K&T) in DOE WAP funded weatherization jobs.

Subgrantees must ensure that a Massachusetts Licensed Electrician performs an electrical safety inspection prior to beginning the weatherization process in all cases where knob and tube wiring is identified. The electrician must provide a written report to the subgrantee regarding the location of all active and inactive K&T wiring prior to any insulation work is done.

If the Knob and Tube wiring has been deactivated, but is still in place and the dwelling has been rewired, then insulation may be placed around and in contact with the inactive Knob and Tube wiring. Insulation may be placed over deactivated knob and tube wiring only after the subgrantee receives written confirmation from a Massachusetts Licensed Electrician.

If the Knob and Tube wiring is active in an open attic or basement area, all insulation must be kept at least three (3) inches from the Knob and Tube. Blown insulation must be appropriately dammed to keep the insulation from advancing closer than 3 inches from the Knob and Tube wiring. If the Knob and Tube wiring is active in sidewall cavities or other restricted areas (floored attics), insulation may not be installed in those cavities. All cavities that do not contain active K & T should be insulated.

Limited replacement of active Knob and Tube wiring is an allowable DOE WAP repair measure. Rewiring is limited by DOE policy to only that which is necessary to allow for the installation of insulation. DOE policy prohibits the complete rewiring of a home because that would be considered a housing rehabilitation measure and is beyond the scope of the WAP.

Knob and Tube wiring inspections and related repairs must be reported in the *Repair* section of the Building Weatherization Report (BWR).

Plumbing-related Health Concerns

Plumbing-related health concerns include :

- Exposure to raw sewage or methane gas.
- Leaking pipes which create high levels of moisture or standing water.
- Lack of water due to frozen pipes.

To minimize exposure :

- Workers must take precautions to avoid direct contact with raw sewage or other unsanitary conditions. Plumbing fixtures must be properly vented to code to avoid build up of methane gas. Clients must be informed of existing conditions and referred to available resources for assistance.
- Leaking pipes must be repaired to prevent water and moisture build-up.
- Energy auditors must be aware of situations that could cause the water pipes to freeze and workers must take precautions to avoid creating circumstances which will allow pipes to freeze.

General Workmanship Practices

Chapter XVII, Subpart C, Item 1926.20 of the Construction Industry OSHA Standards (29 CFR 1926/1910) states: "no contractor or subcontractor for any part of the contract work shall require any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health or safety.

All WAP Technical staff and contractors working in the Massachusetts WAP are strongly encouraged to attend the OSHA 10 Hour Construction Safety Course.

OSHA on Accident Prevention Responsibilities

- (1) It shall be the responsibility of the employer to initiate and maintain such programs as may be necessary to comply with this part.
- (2) Such programs shall provide for frequent and regular inspections of the job sites, materials, and equipment to be made by competent persons designated by the employers.
- (3) The use of any machinery, tool, material, or equipment that is not in compliance with any applicable requirement of this part is prohibited. Such machine, tool, material, or equipment shall either

be identified as unsafe by tagging or locking the controls to render it inoperable or shall be physically removed from its place of operation.

(4) The employer shall permit only those employees qualified by training or experience to operate equipment and machinery."

All WAP personnel, including contractors, working in the Program must conduct themselves within the requirements cited by OSHA. All workers are required to exhibit caution and care during the course of work on the client's homes.

- Use care when working on ladders, in attics, in constricted spaces, or any potentially dangerous situations.
- Use power tools only if familiar with conditions and proper operation of equipment. Be certain that the tools are in good operating condition.
- Wear respirators, protective eye-wear and protective clothing when necessary.
- Provide appropriate clean-up following completion of work.
- Assess structural conditions and demonstrate caution when working in potentially dangerous areas (i.e., on roofs, in attics).
- Do not take foolish chances.

These and other issues are discussed in detail in the OSHA Construction Industry Standards. Subgrantee staff and contractors must become familiar with these regulations.

Backdrafting/Combustion Appliance Zone Testing

Backdrafting occurs when negative pressures in the combustion appliance area exceed the ability of the combustion appliance to create or sustain an adequate draft. Backdrafting may occur at anytime during the run cycle of the combustion appliance. Houses with vented combustion appliances must be tested for spillage and backdrafting as a routine part of the Weatherization process to ensure that the unhealthy byproducts of combustion are not released into the home.

If sufficient negative pressures exist in the room where the appliance is located at the start of a run cycle, the appliance may never establish a positive draft and may backdraft for the entire run cycle. The pressures that are needed to create a backdrafting situation are not that great. Natural draft combustion appliances such as gas fired domestic hot water heaters create only 4-5 Pascal's (Pa) pressure, the fan of a forced warm air furnace distribution system may create up to 30 Pa in the ductwork. Return duct leakage, particularly any leaks that are located near the flue pipe, could cause enough negative pressures in the combustion appliance zone to overcome the draft. Other potential sources of negative pressure include clothes dryers, kitchen or bath fans, fireplaces, wood or coal stoves or anything that exhausts air out of the home. Any work that contributes to tightening the home, thereby reducing the available make-up air, could cause the combustion appliance to backdraft.

Conducting a Backdraft Test

There several methods that may be used to conduct a backdraft test. The simplistic (but marginally accurate) method involves a mechanical approach using smoke, or a draft gauge. The other more accurate method involves pressure testing.

Simplified backdraft testing procedure:

- Establish the worst-case conditions, all exterior doors and windows closed. Turn on all exhaust appliances, furnaces, boilers, water heaters, clothes dryers, and the furnace fan, if applicable. Then, using a draft or pressure gauge, check the exhaust stream of all vented appliances to be certain that there is adequate draft. An alternative to using the draft or pressure gauge is to use a source of smoke at the draft hood or barometric damper of each vented appliance and ascertain that the appliance is drafting properly. If the smoke or air is not moving rapidly up the chimney while all the exhaust and FWA distribution fans are running, a backdrafting problem may exist.

Pressure testing method:

- Establish the worst case conditions as outlined above.
- Close the door leading to the room that contains the vented appliance and measure the pressure difference across that door while the distribution fan and any other exhaust devices located in that room are operating. A negative pressure across the furnace room door is not acceptable. There should be either no pressure difference or a slight positive pressure in the furnace room.
- Open the door to the furnace room. Turn on all exhaust devices throughout the house and leave any doors between those devices and furnace room open. Measure the pressure difference between the furnace room and the exterior of the house by running a hose attached to the pressure gauge to a penetration outside the house.
- Use the House Depressurization table to determine the maximum level of depressurization that is acceptable, based on the heating unit.
- If the depressurization measured in the furnace area is higher than the limit indicated by the table, then the vented combustion appliances are susceptible to extended periods of back-drafting or spillage when exhaust devices are in operation.

House Depressurization Limits (HDL)

Heating Appliance	HDL in Pascals
Gas Combustion Unit, Natural Draft Interior Combustion Air	5
Oil Combustion Unit, Natural Draft Interior Combustion Air	5
Fireplace, Natural Draft Interior Combustion Air	5
Air tight Woodstove	10
Induced Draft Appliance	10

The **Building Performance Institute (BPI)** has established the following protocol for testing combustion appliances for backdrafting and CO concerns in their *Technical Standards for the Building Analyst Professional*:

1. Measure the Base Pressure Differential. Start with all exterior doors and windows closed, and any fireplace dampers closed. Set all combustion appliances to the pilot setting or use the service disconnect. Combustion appliances include: boiler, furnace, space-heaters, fireplaces, and water heater. With the home configured for testing, measure and record the baseline pressure differential between the mechanical room and outdoors.

2. **Establish the Worst Case Conditions.** Turn on the dryer and all exhaust fans including the central vacuum cleaner if there is one. Close all interior doors. Turn on the air handler if there is one. If the base pressure differential in the CAZ does not become more negative, try other combinations of open/closed interior doors. Once the worst case is established, record the net change between the base pressure differential, from the mechanical room to outside, and worst case conditions. Compare to the CAZ Depressurization Limits Table.
3. **Measure Spillage, Draft, CO Under Worst Case Conditions.** Fire the appliance with the smallest Btu capacity first, test for spillage at the draft diverter with a flame or smoke test (or mirror/glasses fogging), and test for CO before the draft diverter after 5 minutes of burner operation. If spillage occurs under the worst-case condition go on to the step 4. If no spillage is found, test the draft in the connector 2 feet after the diverter, or first elbow, and fire all other connected appliances simultaneously. Then test the draft diverter of each appliance for spillage. Test CO levels in all appliances before the draft diverter. Record test results.
4. **Measure Spillage, Draft, CO Under Natural Conditions.** If spillage is found in the first draft hood under worst case conditions, turn off the exhaust fans and open the interior doors with the first appliance operating and test CO levels, spillage, and draft under “natural conditions”. Measure the net change in pressure differential, from worst case to natural, from the CAZ to outside, to confirm the “worst case depressurization” results of Step 2. Repeat the process for each appliance, allowing the vent to cool between tests. Record test results.
5. **Measure Ambient CO Levels.** Monitor the ambient CO in the breathing zone during the test procedure and abort the test if ambient CO goes above 35 ppm. Turn off the appliance, ventilate the space, and evacuate the building. The building may be reentered once ambient CO levels have gone below 35 ppm. (Use judgment about when to reenter and retest.) The appliance must be repaired and the problem corrected prior to completing the combustion safety diagnostics. If the ambient levels continue to exceed 35 ppm during testing under natural conditions, disable the appliance and instruct the homeowner to have the appliance repaired prior to operating it again. Record ambient CO levels and their locations.

Recommend repairs based on test results and the accompanying tables:

Combustion Appliance Zone (CAZ) Depressurization Limits

Venting Condition	Limit (Pascals)
Orphaned natural draft DHW heater	-2
Natural draft boiler or furnace w/o damper and vented in common with water heater	-3
Other configurations of natural draft boiler or furnace, with or without venting in common with water heater	-5
Induced draft boiler or furnace vented in common with water heater	-5
Power vented or induced draft boiler or furnace vented independently of water heater, or power-vented water heater	-15
Chimney-top draft inducer; High static pressure flame retention head oil burner; Direct-vented and/or sealed combustion appliances	-50

If a home fails a backdraft test, it is crucial that the agency develop a strategy to alleviate the problem

The venting system of the offending appliance must be thoroughly checked for any problems or obstructions. Providing external combustion and/or ventilation air to the appliance may help. Sealing leaks on the return side of forced warm air distribution systems also may help. At times the basement perimeter must be left

deliberately leaky to prevent negative pressure build up in the basement unless combustion air can be provided directly to the appliance.

Note: An excellent simplified explanation of using the Energy Conservatory's DG-700 Digital Manometer to identifying back-drafting problems can be found in Anthony Cox's presentation at Affordable Comfort:

http://www.affordablecomfort.org/images/Events/23/Courses/697/DUR3_Cox_CAZ_and_Draft_CheatSheet.pdf

WAP Deferral of Services Policy

The Massachusetts DOE WAP Health and Safety Guidance allows subgrantees, in extreme situations, to defer or provide no weatherization or heating system services to homes that have significant health or safety concerns that the subgrantee believes that the client, energy auditor or contractor in the home may be endangered by performing the weatherization work.

The U.S. Department of Energy (DOE) states that the deferral policy should not mean that assistance would never be provided, but “that services must be postponed until the problems can be resolved and/or other sources of help are found.” DOE requires that subgrantees complete the “Notice of Deferral of Services Form” found in this Technical Manual and provide DHCD with a copy when weatherization services must be deferred.

According to DOE guidance, Health and Safety conditions that may cause the deferment of providing weatherization and HEARTWAP services include:

1. The client has known health conditions that prohibit the installation of insulation and other weatherization materials.
2. The building structure or its mechanical systems, including electrical and plumbing, are in such a state of disrepair that failure is imminent and the conditions cannot be resolved cost-effectively.
3. The house has sewage or other sanitary problems that would further endanger the client and weatherization installers if weatherization work were performed.
4. Moisture and/or mold related problems are severe and cannot be resolved under existing health and safety measures and with available repair funds.
5. Dangerous conditions exist due to high carbon monoxide levels in combustion appliances, and cannot be resolved under existing health and safety measures.
6. The client is uncooperative, abusive, or threatening to the subcontractors, auditors, inspectors, or others who must work on or visit the house.
7. The extent and condition of lead-based paint in the house would potentially create further health and safety hazards.
8. Illegal activities are being conducted in the dwelling unit.
9. In the judgment of the energy auditor, if any condition exists which may endanger the health and/or safety of the subcontractor, the work should not proceed until the conditions are corrected.

In addition to the above cited Health & Safety related deferral provisions of weatherization and HEARTWAP services, subgrantees **may not** provide Weatherization services if the following conditions are present:

1. A dwelling unit is for sale.
2. A dwelling unit is scheduled for demolition or is condemned.
3. A dwelling unit has not received an occupancy permit.

DOE and DHCD requires subgrantees to act as advocates for clients with health and safety concerns to insure that problems are resolved so that the weatherization work can eventually be performed.

MASSACHUSETTS WEATHERIZATION ASSISTANCE PROGRAM
NOTICE OF DEFERRAL OF SERVICES

Agency _____ Energy Auditor _____

Client Name _____ Phone # _____

Address _____

Date of Inspection _____

During an inspection by the above named Weatherization Subgrantee, the following Health and Safety problem(s) were noted:

The problem(s) listed above do not exclude your household from receiving the benefits of the Weatherization Program. When the above condition(s) are rectified, your household may still receive services, provided the household is still eligible and there is funding available.

_____ I (client initials) understand that the above condition(s) prevent my home from being weatherized at this time.

_____ It is my (client initials) responsibility to contact the agency when the problem has been corrected.

_____ It is my (agency representative initials) responsibility to contact alternative funding sources.

If a request for alternative funding sources is checked, list the possible sources and contact persons:

Source _____ Contact Person _____ Date _____

Source _____ Contact Person _____ Date _____

I (the client) clearly understand that the condition(s) outlined above prevent my home from being weatherized at this time. I also understand the responsibilities of all parties involved, including my responsibilities. By signing this document, I understand that I am not giving up my rights to my benefits provided by the Weatherization Program. It is in the best interests of all parties involved that weatherization assistance not take place until the problem(s) are resolved.

(Client Signature)

(Date)

(Agency Representative Signature)

(Date)

Copy to DHCD/ ECU

Massachusetts Weatherization Assistance Program
Mold Inspection and Release Form

Mold can be a problem in any home, but especially in those where an excessive amount of moisture or humidity is present. In addition, if there are several people, pets, plants, or fish aquariums present, conditions exist for mold growth. (Agency) may not provide direct mitigation of existing mold problems. An assessment of your home included a visual check for mold.

During (Agency) energy audit on (DATE: _____), our auditor/estimator identified mold growth in the following room(s):

- ☐ Living/Bedroom Areas
- ☐ Laundry Areas
- ☐ Crawlspace Areas
- ☐ Basement Areas

- ☐ Bathroom Areas
- ☐ Combustion Areas
- ☐ Attic Areas
- ☐ Other Location

Other Location: _____

Moldy or musty odors are an indicator that there may be hidden mold growth. Moldy or Musty Odors:

- ☐ Are present. ☐ Are not present.

The US Department of Energy generally does not allow Weatherization agencies to mitigate mold problems, but some actions associated with a cost-effective energy saving measure may be taken to reduce moisture problems. **The (Agency) will take the following measures that may help to mitigate existing moisture problems:**

- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

Please check off and then sign one of either the Notification or Disclaimer below:

☐ **Moisture Disclaimer:** I have received information concerning moisture and mold conditions in my home, including the EPA booklet “*A Brief Guide to Mold, Moisture, and Your Home*” <http://www.epa.gov/iaq/molds/images/moldguide.pdf> (if mold conditions have been identified) and I will take steps to reduce excessive moisture. I agree to hold (Weatherization Agency) harmless for any future moisture or mold problems that are not associated with the weatherization work. (Maintain this copy in the client file.)

Weatherization Client

Date

Agency Energy Auditor/Estimator

Date

☐ **Deferral Disclaimer:** Advise the client that the (Agency) cannot cost effectively resolve the identified mold or moisture. Document who will be responsible for the corrective action. Explain and list the conditions that justify the agency to “DEFER” the work and have the client sign and date in the space below indicating agreement to planned action. Maintain this copy in the client file.

Weatherization Client

Date

Agency Auditor/Estimator

Date

IV. MASSACHUSETTS WEATHERIZATION MEASURES PRIORITY LISTS BY HOUSING TYPE

The Massachusetts Weatherization Assistance Program's priority lists of weatherization measures by housing types were developed by completing sample audits on a variety of typical housing types, with different insulation levels and fuel sources, using the Department of Energy's National Energy Audit (NEAT) for single family and small individually heated multifamily homes and the Manufactured Home Energy Audit (MHEA) for manufactured housing (mobile homes). DHCD then submitted the sample audits and the recommended Priority Lists to DOE, along with the WAP Technical Manual for approval. The most recent approval of the priority list was received in October 2008.

While the priority lists are appropriate for most housing, there are homes and situations that dictate that an energy audit is appropriate and necessary. In those cases, the subgrantee must complete an energy audit using a DOE approved audit for that building type to determine the priority measures. Subgrantees may choose to complete an audit on any home receiving weatherization services in lieu of using the Priority Measures list.

Examples of currently approved audits include:

- Single-family (1-4 units): NEAT, REM/Rate, EA-QUIP, TREAT, SMOC-ERS
- Multi-family (5-25 units, individually heated/cooled): NEAT, REM/Rate, EA-QUIP, TREAT
- Multi-family (all greater than 5): EA-QUIP, TREAT
- Manufactured Housing: MHEA, REM/Rate, TREAT

DOE may approve other audits as requested. Check with DHCD if there are any questions about an energy audit's approval status.

MA WEATHERIZATION PRIORITY MEASURES:

SINGLE FAMILY AND SMALL MULTI-FAMILY (ONE TO FOUR UNITS)

<u>PRIORITY</u>	<u>SOURCE OF HEAT LOSS AND REMEDY</u>
------------------------	--

- | | |
|-----|---|
| 1. | <p><u>Major Air Sealing/General Heat Waste/Duct Sealing</u></p> <p>Complete comprehensive Blower Door Directed Air Sealing and seal all leaking ductwork based on the protocol outlined in the Massachusetts WAP Technical Manual.</p> |
| 1a. | <p><u>Primary Heating System</u></p> <p>Complete safety and efficiency improvements on the primary heating system based on the guidelines outlined in the most recent HEARTWAP Program Guidance. Heating system work should first be referred to HEARTWAP provided sufficient funds exist in that program.</p> |
| 2. | <p><u>Uninsulated Attic (less than an effective R-19)</u></p> <p>Install attic insulation up to R-38 or R-49 for electrically heated units. The attic must receive a thorough air sealing protocol prior to the installation of insulation based on the protocol outlined in the Massachusetts WAP Technical Manual.</p> |
| 3. | <p><u>Uninsulated Walls</u></p> <p>Insulate the sidewalls with a blown-in insulation that provides effective air sealing and a minimum R-13 when installed in a “typical” 3.5 inch wall cavity. Cellulose insulation must be installed at a density greater than 3.5 lbs/cubic foot. Any other blown fiber or foam insulation must be installed at a density that provides comparable air sealing properties according to third party verified tests. All cavities must be thoroughly probed prior to the installation. Insulation coverage must be complete.</p> |
| 4. | <p><u>Compact Fluorescent Lighting</u></p> <p>Install a maximum of 12 compact fluorescent light (CFL) bulbs in fixtures or lamps. There are no minimum hours of use requirement. CFL installations must be in compliance with the guidelines outlined in the Massachusetts WAP Technical Manual and the Appliance Management Program (AMP). If a utility’s AMP funding is available for the dwelling unit, those funds should be utilized.</p> |
| 5. | <p><u>Uninsulated Floors</u> (<i>Unconditioned Basements Only</i>)</p> <p>Insulate the floors of dwelling units with an unconditioned basement with R-30 fiberglass batts. The fiberglass must be mechanically fastened and all large series leakage paths must receive the proper air sealing treatment prior to the installation of the insulation.</p> |

5a. or, Uninsulated Perimeter (Conditioned Basement)

Insulate the inside of the exposed foundation walls from the top of the floor joist area to below grade with an R-7 vinyl or foil faced duct insulation as per the specifications outlined in the Massachusetts WAP Technical Manual.

6. Uninsulated Space Heating Ducts or Pipes

Insulate the space heating ducts with R-5 duct insulation. The insulation must be mechanically fastened and all seams on the ductwork must be properly sealed according to specifications outlined in the Massachusetts WAP Technical Manual prior to the installation of the insulation or:

Insulate all uninsulated hydronic or steam pipes with commercially available pipe insulation appropriate for the pipe temperature in accordance with the Massachusetts WAP Technical Manual.

7. Partially Insulated Attic (effective R-19 or greater)

Install attic insulation up to R-38 or R-49 for electrically heated units. The attic must receive a thorough air sealing protocol, including the moving and replacing of existing insulation, prior to the installation of the additional insulation based on the protocol outlined in the Massachusetts WAP Technical Manual.

8. Minor General Heat Waste/Interior Storm Windows/Movable Insulation Systems

All other eligible and cost-effective weatherization measures.

Prime Window Replacement Policy:

Replacement windows are not listed as an allowable measure based on the WAP Priority Measures system. If the existing window(s) in a weatherization unit are single glazed or are in poor condition, subgrantees may install replacement windows that *are at a minimum* Energy Star Rated for the Northern Climate Zone provided that the installation is cost justified by a savings to investment ratio (SIR) of 1.0 or greater by the use of a DOE WAP approved audit that was completed for the dwelling unit. If the audit indicates that the SIR is less than one, and the existing window is beyond repair and creating a serious infiltration and heat loss problem in the unit, then the weatherization agency may expend up to \$350 in DOE WAP *Health and Safety* funds to replace the defective window.

See *Section V. Replacement Window/Doors* of this manual for further information and standards.

MA WEATHERIZATION PRIORITY MEASURES:

MULTI-FAMILY (5+ Units) PRIORITY LIST

<u>PRIORITY</u>	<u>SOURCE OF HEAT LOSS AND REMEDY</u>
------------------------	--

1.	<u>Major Air Sealing/General Heat Waste/Duct Sealing</u>
----	--

Complete comprehensive Blower Door Directed Air Sealing and seal all exposed ductwork based on the protocol outlined in the Massachusetts WAP Technical Manual.

1a.	<u>Primary Heating System</u>
-----	-------------------------------

Complete safety and efficiency improvements on the primary heating system based on the guidelines outlined in the most recent HEARTWAP Program Guidance. Heating system work should be referred to HEARTWAP provided sufficient funds exist.

2.	<u>Uninsulated Attic (less than an effective R-19)</u>
----	--

Install attic insulation up to R-38. The attic must receive a thorough air sealing protocol prior to the installation of insulation based on the protocol outlined in the Massachusetts WAP Technical Manual.

3.	<u>Uninsulated Walls</u>
----	--------------------------

Insulate the sidewalls with a blown-in insulation that provides effective air sealing and a minimum R-13 when installed in a “typical” 3.5 inch wall cavity. Cellulose insulation must be installed at a density greater than 3.5 lbs/cubic foot. Any other blown fiber or foam insulation must be installed at a density that provides comparable air sealing properties according to third party verified tests. All cavities must be thoroughly probed prior to the installation. Insulation coverage must be complete.

4.	<u>Compact Fluorescent Lighting</u>
----	-------------------------------------

Install a maximum of 12 compact fluorescent light (CFL) bulbs in fixtures or lamps. There are no minimum hours of use requirement. CFL installations must be in compliance with the guidelines outlined in the Massachusetts WAP Technical Manual and the Appliance Management Program (AMP). If a utility’s AMP funding is available for the dwelling unit, those funds should be utilized.

5.	<u>Uninsulated Floors (<i>Unconditioned Basements Only</i>)</u>
----	---

Insulate the floors of dwelling units with an unconditioned basement with R-30 fiberglass batts. The fiberglass must be mechanically fastened and all large series leakage paths must receive the proper air sealing treatment prior to the installation of the insulation.

5a.	<u>or, Uninsulated Perimeter Conditioned Basement:</u>
-----	--

Insulate the inside of the exposed foundation walls from the top of the floor joist area to below grade with an R-7 vinyl or foil faced duct insulation as per the specifications outlined in the Massachusetts WAP Technical Manual.

6. Uninsulated Space Heating Ducts or Pipes

Insulate the space heating ducts with R-5 duct insulation. The insulation must be mechanically fastened and all seams on the ductwork must be properly sealed according to specifications outlined in the Massachusetts WAP Technical Manual prior to the installation of the insulation or:

Insulate all uninsulated hydronic or steam pipes with commercially available pipe insulation appropriate for the pipe temperature in accordance with the Massachusetts WAP Technical Manual.

7. Partially Insulated Attic (R-19 or greater)

Install attic insulation up to R-38 or R-49 for electrically heated units. The attic must receive a thorough air sealing protocol, including the moving and replacing of existing insulation, prior to the installation of the additional insulation based on the protocol outlined in the Massachusetts WAP Technical Manual.

8. Minor General Heat Waste/Interior Storm Windows/Movable Insulation Systems

All other eligible and cost-effective weatherization measures.

Prime Window Replacements Policy:

Replacement windows are not listed as an allowable measure based on the WAP priority system. If the existing windows in a weatherization unit are single glazed or are in poor condition, then subgrantees may install replacement windows that *are at a minimum* Energy Star Rated for the Northern Climate Zone provided that the installation is cost justified by a savings to investment ratio (SIR) of 1.0 or greater by the use of a DOE WAP approved audit for the building type that was completed for the dwelling unit. If the audit indicates that the SIR is less than one, and the existing window is beyond repair and creating a serious infiltration and heat loss problem in the unit, the subgrantee may expend up to \$350 in DOE WAP *Health and Safety* to replace the defective window.

See *Section V. Replacement Window/Doors* of this manual for further information and standards.

WEATHERIZATION PRIORITY MEASURES:

MANUFACTURED HOUSING PRIORITY LIST

PRIORITY **SOURCE OF HEAT LOSS AND REMEDY**

1. Major Air Sealing/General Heat Waste Reduction/Duct Sealing

Complete comprehensive Blower Door Directed Air Sealing and seal all exposed ductwork based on the protocol outlined in the Massachusetts WAP Technical Manual.
- 1a. Primary Heating System

Complete safety and efficiency improvements on the primary heating system based on the guidelines outlined in the most recent HEARTWAP Program Guidance. Heating system work should be referred to HEARTWAP provided sufficient funds exist.
2. Floor/Belly Insulation

Insulate the floor area with either a loose fill blown cellulose or fiberglass insulation filling the cavity to capacity or if the belly area is exposed and accessible, use a fiberglass batt (R-19 or greater) and cover the exposed batts with a vapor permeable membrane (Tyvek or equal).
3. Roof Insulation

Insulate the roof area with blown cellulose or fiberglass up to R-38 or to the capacity of the cavity.
4. Compact Fluorescent Lighting

Install a maximum of 12 compact fluorescent light (CFL) bulbs in fixtures or lamps. There are no minimum hours of use requirement. CFL installations must be in compliance with the guidelines outlined in the Massachusetts WAP Technical Manual and the Appliance Management Program (AMP). If a utility's AMP funding is available for the dwelling unit, those funds should be utilized.
5. Interior Storm Windows

Add interior storm windows to single glazed windows. The interior window must be a rigid glazing material with a rigid frame and mechanically fastened to the window frame.
6. Prime Window Replacements

Install Replacement Windows that are at a minimum, Energy Star Rated for the Northern Climate zone. Maximum cost of \$350 per window and maximum of \$3,500 in replacement window costs per eligible manufactured housing unit.

IV. WEATHERIZATION MEASURES **IN ORDER BY PRIORITY LIST NUMBER**

PRIORITY 1: MAJOR AIR SEALING / GENERAL HEAT WASTE / DUCT SEALING

The Major Air Sealing/General Heat Waste/Duct Sealing category is to be considered as Priority #1 for all housing types. It includes the following mandatory weatherization measures which must be completed, if applicable, before advancing to any subsequent priority item lower down on the list.

- Identify and seal major bypasses and significant leaks with an emphasis on those leaking to the attic. To the greatest degree feasible, expose leaking top plates and openings to the attic areas and seal with an appropriate material. Comprehensive, targeted air sealing as needed, must be completed before any insulation is added and prior to completing any other priority measure even if no additional insulation is added.
- Identify and seal appropriate key juncture areas.
- Seal leaking warm air ductwork joints (supplies and returns) with an appropriate mastic or a butyl-backed aluminized tape and repair all duct work breaks as needed.
- Weatherstrip doors as needed between heated and unheated spaces.
- Limited weatherstripping and interior caulking as needed for gross air leakage and to increase comfort.
- Air seal and insulated the sill box area.
- Fireplace damper.

MAJOR AIR SEALING PRIORITIES

This guidance is not intended to provide extensive information about the building science and theory behind making energy efficiency improvements in residential housing. The intention is to provide basic information on appropriate methods and basic standards and requirements of the Weatherization Assistance Program in Massachusetts.

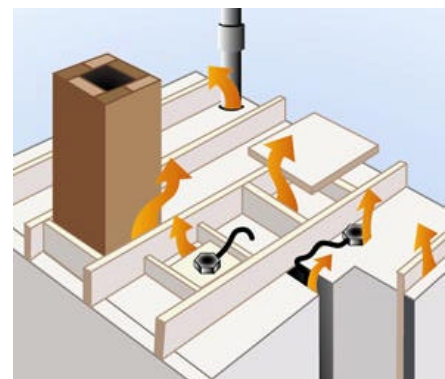
Blower door directed air sealing is a comprehensive approach to controlling infiltration in a home. By reducing air leakage and blocking thermal bypasses, a well developed air sealing strategy can make a home less drafty, more comfortable, increase the effectiveness of insulation measures, save significant heating and cooling costs and increase the durability of the home. An important part of the process of identifying and prioritizing the air sealing and insulation requirements of the building is to identify the appropriate thermal boundary of the building and make certain that the boundary is continuous as possible and that the air barrier and insulation are in direct contact.

Any work that reduces the air infiltration rate, must also address concerns about indoor air quality and the venting of combustion by-products. Before any work is completed there must be a thorough evaluation of the home to identify and provide solutions for a variety of potential indoor air quality problems and combustion system venting requirements. These concerns and required protocol are addressed in the **DHCD WAP Health and Safety Guidance** included in this Technical Manual. Required at a minimum is: an evaluation and mitigation of potential indoor air quality problems, including moisture problems and related mold concerns; carbon monoxide testing of all combustion appliances, and backdraft testing of all vented combustion appliances. All evaluation, testing, and mitigation must be completed both before the weatherization work is started and retested after all weatherization work is completed.

All single family and mobile homes must receive a pre-WAP and post-WAP single-point blower door test which will provide the subgrantee with a pre and post cubic feet per minute infiltration rate at fifty Pascal (CFM@50 Pa). DHCD also strongly encourages the use of blower door testing in multi-family homes. The results of the tests must be recorded and included as part of the WAP audit and quality control information. This requirement can only be waived if there are justifiable concerns that the health and safety of the occupants or testers may be compromised by conducting the blower door test (e.g., friable asbestos is present in the home). Justification for not completing the test must be included in the WAP client file. The blower door test may be completed by the WAP auditor or a contractor, but if the contractor is completing the test, the subgrantee must be able to verify the results. If the agency energy auditor is not completing the blower door test during the initial inspection, it is ***strongly*** recommended the auditor meet the contractor during the initial test. This will give the auditor and the contractor the opportunity to discuss the results of the test, identify major air leakage areas, and to discuss the proposed work. Photographic documentation provided by the auditor to the contractor and included in the client file, will also assist the contractor in determining areas that the WAP auditor wants addressed.

Since the standard cfm 50 test does not incorporate the volume of the house, DHCD recommends that auditors become familiar with and calculate the Air Changes per Hour at 50 Pascal (ACH50) and the Air Changes Natural (ACH_N) and use the resulting information to assist in prioritizing an air sealing strategy.

Prioritizing the air sealing work must involve an understanding of how air moves and leaks through the building envelope, estimating the resources in time and dollars invested that should be devoted to air sealing (based on the air leakage rate and the



amount and type of other work required on the home), and understanding the interactions that occur between the structural and mechanical systems of the home. The energy auditor and Weatherization contractor must become familiar with effective air sealing techniques and materials. The energy auditor must also be aware of the recommended Building Tightness Limits (BTL), the interaction of some insulation measures (primarily dense pack wall insulation) with the infiltration rate, and the effect that reducing the infiltration rate will have on the concentration of indoor air pollutants and the venting of combustion appliances.

One of the most effective methods for identifying attic air leakage areas is to conduct a blower door test in conjunction with an infrared scanner. To accomplish this, interior partitions and suspected key junctures should be scanned prior to conducting the blower door test. After the initial CFM@50 Pascal test is completed, the blower door can be turned down to a lower level and the suspect areas rescanned. Attic air leakage areas will be revealed as hot or cold streaks on the interior walls depending on the attic temperature.



Other methods to identify air leakage area include some very simple tests. With the blower door running, close an interior door so that there is small gap between the door and the jamb and note the air flow. Compare the intensity of the flow with that of other rooms using the same technique. The rooms with the greatest flow may give an indication of the leakier areas. Another technique is to run a blower door test with interior doors and basement door closed then run the test with doors open and compare the CFM₅₀ results. A good visual technique is to use a source of smoke around cracks or potential leaks and observe the movement of the smoke. This works in the attic, basement and living space.

There are also a variety of pressure differential tests that can be conducted with a digital (better) or analog manometer in conjunction with the blower door that will assist in identifying areas that require air sealing work as well as providing information about pressure differences in different zones and/or cavity spaces (knee walls, porch roofs, cantilevered floors) in the home. Additional information and protocols for zonal and pressure testing can be found in section 2.3 of the *Northeast Weatherization Field Guide*.

For a leak to occur in a building there must be two components: a hole, and a driving force to move the air through the hole. The amount of leakage through any hole is directly proportional to the size of the hole and the amount of pressure across it. It therefore makes the most sense to concentrate initial air sealing efforts in the areas with the largest holes that are under the highest pressure. Due to the stack effect creating high exfiltration pressures in the upper regions of the building and the large number of potential holes or bypasses in the attic/living space interface, the initial air sealing efforts should be focused on identifying and sealing air leakage areas to the attic.

The top plates of walls that intersect the attic are a major source of air leakage into the attic. Most plumbing and electrical penetrations pass through the top plates and the juncture of the sheetrock to the stud walls effective treatment is to pull back existing insulation to expose the top plates and seal the entire plate generally is not airtight. These areas are relatively easy to identify, expose and treat.



Black stained streaks in attic fiberglass insulation are a clear indication that an air leak exists as the fiberglass filters impurities and particulates in the heated air entering the attic from the living space.

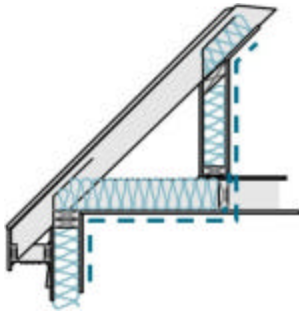
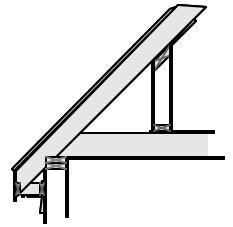


Many of the leakage areas to the attic are part of a series leak that may start either in the living space or the basement. In most of these series leaks, if the leak is controlled in the attic, there may be no need to seal the other areas in the series. Some of these potential leakage areas include: chimney chases, plumbing chases, bathroom plumbing walls, attic access ways (including pull-down stairways), open or unsealed top plates, especially in balloon framed homes, the center bearing wall top plate especially in modular homes, split levels and balloon framed structures, around electrical junction boxes.



The chimney chase in many buildings represents a major source of air leakage into the attic and is a leak that requires special consideration on methods and materials for sealing the opening since the chimney is a heat producing device. Sealing the chimney chase requires compliance with fire code regulations that no combustible materials are installed within 3 inches of the heat producing chimney. **Chimney chases must be sealed with a fire retardant material such as sheet metal and any sealant used within 3 inches of the chimney must be an appropriate high temperature sealant which meets ASTM E136.** The method of sealing the chase must be effective; flashing sealed at the chimney and to a floorboard in the attic may not be an effective seal. The chase may “leak” directly to the joist space below the flooring. If this is the case, the flooring must be cut back and the leak sealed at the ceiling level.

Another area that requires careful inspection and evaluation is a number of key junctures in the home. Whenever there is a junction of dissimilar materials or areas of structural change in the building, the potential for significant leakage areas exist. Particularly problematic is the kneewall/kneewall floor junction in the Cape Cod style home. In many Cape style kneewall attics there is a direct connection of the joist space between the first and second floors of the home and the outside. Proper treatment of this area can result in significant air leakage reductions.

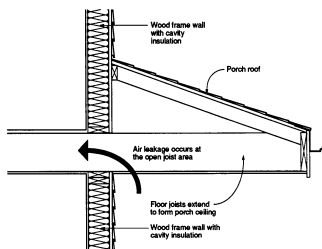
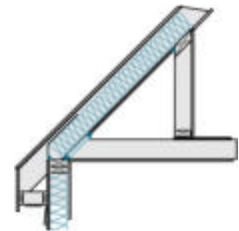


There are two distinct methods of treating the Cape style attic. One method involves sealing the kneewall-kneewall floor transition area and insulating the kneewall, kneewall floor and slope. This method requires that any doors, access ways or built-in storage (drawers) be air sealed or weatherstripped as needed and insulated. In this instance the air and thermal barrier runs down the slope to the kneewall, the treated kneewall floor transition area and the ceiling of the floor below. The transition area can be sealed in a variety of methods including dense-packed with an appropriate blown-in insulation or pieces of a solid material (foam, plywood) cut and fit in the area and the

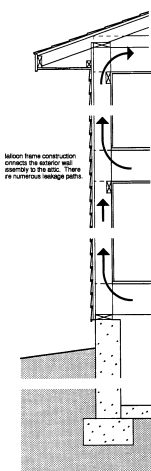
edges sealed.

An alternative method of treating the area involves defining the thermal boundary along the slope from the attic flat down to the outside wall. This method brings the kneewall area inside the thermal boundary and while it does create a larger heated area, it creates a simplified air and thermal barrier and eliminates the need for air sealing, weatherstripping and insulating access ways and built-in storage areas.

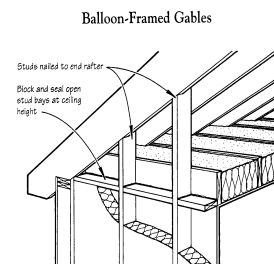
If this method is chosen, the thermal and air barrier runs down the slope to the floor. There may be a need to air seal the floor joists at the outside wall depending on the framing. The gable end walls will also need to be insulated as the kneewall area is now within the heated envelope.



Other key juncture areas to pay particular attention to include, cantilevered floor areas, offset floors and ceilings, the central wall of split-level homes, and the wall/roof area where a roofed porch meets the sidewall of the home. Porch roof/wall intersections have two major potential problem areas. First, many ceiling areas of porches are created as extensions of the home's ceiling joists, leaving an open cavity from above the porch ceiling into the area between the floors. The second problem in this area is that in older homes with plank (rather than plywood) sheathing, the area between the porch roof and ceiling may be open to the sidewall cavity. In many homes, the gable end studs may be balloon framed. If this condition exists, special attention to this area is warranted.

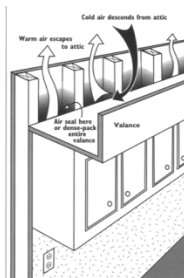
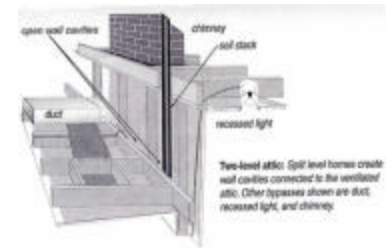


The sidewalls of balloon-framed structures are a major air leakage area. Since by design, the framework is open at the bottom and top of each bay and into each joist cavity between floors, balloon framed walls communicate directly from the basement to the attic and between the floors throughout the building. Insulating the walls with dense pack cellulose is a very cost effective solution to the problem. In many balloon-framed homes the central bearing partition is also balloon framed and should be air sealed in the attic (and in the basement if needed).



Split level homes pose many potential air leakage areas particularly any wall cavities connected to ventilated attics or crawlspaces.

Most modular homes are delivered in at least two sections. The juncture of any sections (typically the central partition walls) is an area that will need to be identified and sealed.

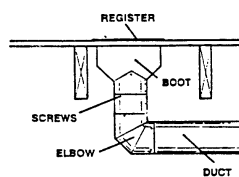


The soffit area in some kitchen cabinets and showers with a soffit-like enclosure may be open to the attic.

Special attention must also be paid to the mechanical systems of homes with a forced warm air distribution system. The ductwork of many forced warm air systems leak extensively. Leaking ductwork can contribute a significant amount to the CFM50 leakage identified by the blower door test. In addition, since the ductwork is operating under a high pressure created by the

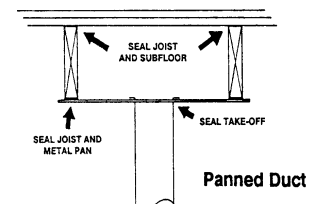


distribution fan, the effect of duct work leakage is exaggerated significantly. Leakage on the supply side of the distribution system, both in the seams of the ductwork, and in any breaks or disconnected ductwork, waste heat in an area that is generally unintended to be heated and may cause areas of the home to be inadequately heated. The return side of the ductwork is usually leakier, since the



Potential Leakage Sites Around Floor Register

installing contractor generally paid less attention to the return side connections. The seams of panned floor joists used as a return line may leak extensively. In addition, in most homes there is significantly less return side air than on the supply side, causing the distribution system to get a large portion of its return air through the cracks in the return ductwork. This phenomenon can cause significant negative pressures in the basement,



enough to backdraft combustion appliances. Sealing and repairing both the supply and return side of forced warm air distribution systems are a very important component of any air sealing protocol.

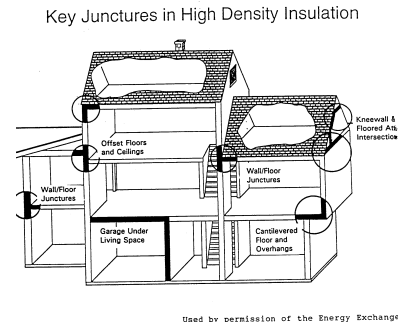
While leaking ductwork can be a significant contributor to the overall infiltration rate, the presence of the warm air system provides the auditor with two potential air sealing problems. First, the existence of a powerful air handler to distribute the heated air throughout the house creates pressure differences while the fan is operating, exaggerating any existing leakage areas by blowing heated air through the holes. Second, since most distribution systems are poorly balanced and have insufficient returns in many rooms, different parts of the home may be experiencing vastly different levels of exfiltration or infiltration pressures.

There are also times that air sealing work in the basement of the home makes sense. Large plumbing chase leaks, such as the drain cutouts under the bathtub, may be part of a series leak that cannot effectively be sealed in the attic. Chimney chases that can be effectively sealed in the attic need not necessarily be sealed in the basement. Testing for leakage with a blower door after the attic chimney chase is sealed in the attic can determine if it needs to be sealed in the basement. Large leakage areas in the foundation wall, cellar access doors, and cellar windows may be easy to seal at a relatively low cost. Caution must be used when sealing the basement perimeter if those leaks are the primary source of combustion and ventilation make-up air for combustion appliances located in the basement. It is important to allow for sufficient air for proper ventilation and combustion and to prevent depressurizing the area where combustion appliances are located. In tight basements or when the heating system is in a small area, it may make sense to duct combustion air directly to the heating system if it is not a direct vent system.

The living spaces of homes are also areas that may need to receive air sealing work. Any obvious leaks directly to the outside, such as missing or broken glass, should be repaired. The fireplace and its damper is a potentially large hole with a built in stack that should be addressed when needed. Occupants tend not to feel leakage around the fireplace since they tend to exfiltrate large volumes of air, creating a draft of makeup air somewhere else in the home. Homeowner's frequently leave the damper open without realizing it. A commercially available "air pillow Draftstopper" or a plywood hatch can be used to stop the leak. Large holes in ceilings and walls should be repaired. Doors between heated and unheated spaces may need to be weatherstripped. Extremely loose windows, particularly those in the spaces frequently used by the occupants may need to be tightened. The area above suspended ceilings should be investigated and repaired as needed.

The auditor and WAP contractor must also consider the impact of wall insulation on the infiltration rate in the home. Dense pack insulation installed at a density adequate to eliminate air movement is a very effective air sealing measure and may significantly reduce the home's infiltration rate. If walls are to be completed on a home, particularly one with a balloon frame, this must be considered a factor in the total air sealing package.

Dense packing walls may be the most cost effective measure that can be completed on many homes, considering combined infiltration and conductive loss reductions.



Equally as important as the air sealing work, is how tight a house can be air sealed and still maintain acceptable, safe indoor air quality. Homes must have some ventilation to provide a supply of clean, fresh air to maintain an acceptable level of indoor air quality and to provide adequate air for combustion appliances. While the chart of minimum acceptable Building Tightness Limits (BTL) provides generalized information, it is important to recognize that homes with high source strength pollutants or high background moisture levels that cannot be mitigated should not be tightened and the proper venting of combustion appliances must be established through backdraft testing.

BUILDING TIGHTNESS LIMITS (CFM/50 minimum)

Number of Stories	1	1.5	2	3
Well Shielded	1,665	1,500	1,330	1,165
Normal	1,390	1,250	1,110	1,000
Exposed	1,250	1,125	1,000	1,000

Shielding Factors :

Well-Shielded.....Urban areas surrounded by buildings.

Building surrounded by trees, bermed earth, protected by hillside.

Normal.....Residential neighborhood with yard space between buildings.

80-90% of houses will fall into this category.

Exposed.....Buildings in a very open setting, limited trees, few buildings.

Buildings on top of a hill or exposed to open ocean or large lakes.

These Building Tightness Limits are based on five (5) occupants in the home. Add approximately 200 CFM/50 per person for larger households. This chart also assumes no high source strength pollutants are present. The CFM/50 must be raised for smokers, homes with high levels of moisture

or any other indoor air quality concerns that cannot be mitigated. Homes with serious indoor air quality problems should not receive air sealing work until the problems can be corrected. More accurate recommended BTL's can be determined by using energy audit software such as DOE's National Energy Audit (NEAT), or the software available through the manufacturers of blower doors.

These BTLs do not consider minimum safe depressurization levels to provide for the proper ventilation of combustion appliances. Backdraft testing must be completed to ensure that all combustion appliances are safely vented to the outside in the worst case depressurization conditions. Providing combustion air will not necessarily solve a backdraft problem if depressurization levels are high enough.

Auditors must also consider what is a reasonable investment in program resources for air sealing measures. The most effective air sealing techniques are generally not very costly in materials and labor although some measures may require more work in less than desirable locations. The goal in any air sealing strategy is to complete the most effective air sealing for a reasonable cost. The aim is to locate and seal the largest holes in the most important locations (attics and key junctures) and to regularly test the effectiveness of the work using the blower door. The WAP contractor must concentrate their initial air sealing efforts at identifying and sealing the largest holes and leaks in the most crucial areas (the attic and key junctures) rather than spend a lot of time sealing smaller less significant leaks in the basement. The initial efforts must be aimed at identifying major bypasses into the attic, key juncture leakage areas, balloon frame bypasses, bypasses that start in the basement and end in the attic, and any large leakage areas that lead directly into the living spaces from the outside (broken glass, holes in the walls).

Blower door directed air sealing should continue until the contractor reaches the minimum BTL or the work that is being completed is no longer cost effective. Contractors should take regular blower door tests during the air sealing work to determine the effectiveness of the work that has been completed. It is generally not cost effective for a contractor to spend significant time attempting to locate and seal small, insignificant leaks. In most homes, the cost of the air sealing work should not exceed \$300-500 (exclusive of wall insulation or sealing key junctures that involve the blowing of dense pack cellulose). WAP Auditors must work closely with the contractors to clearly specify the areas to receive air sealing work, and how much work is to be completed. If contractors locate additional areas in need of work, or require additional time to complete their air sealing work, there must be documentation of agency authorization for the additional work. If contractors are paid by the hour for materials and labor to complete air-sealing work, the contractor's invoice must document the measures completed for the time allocated. Air sealing work that is subsequently covered with a blown in insulation without an agency inspection prior to the insulation being added, must be verified by the contractor by supplying the subgrantee with digital pictures of the work.



Techniques and materials used to accomplish air sealing measures must be appropriate to the area being sealed. The key to any method or material used for air sealing is effectiveness of the work. Large holes must be sealed with a material that ensures that the air sealing is effective. Solid material such as rigid foam board, plywood, or sheetrock fastened in place and sealed along the edges with foam or caulking will accomplish this. Fiberglass batts stuffed into a hole is not an effective air sealant. Fiberglass batts stuffed into a plastic trash bag and then stuffed into an opening is also not an effective air sealing method unless it completely fills the gaps and the edges are sealed. However, fiberglass bagged or not, can be used as a backing or damming for other materials in appropriate situations. The material

used to seal the openings is not the primary concern. As long as it is safe and is in compliance with building codes, the primary concern is that the installation performs the desired effect of sealing the air leak.

One of the more useful materials for air sealing is expanding foam. The foam can fill cracks and holes that are too large for caulking and the expanding nature of the product allows it to effectively fill odd sized or shaped openings. Two part expanding foam is especially effective at sealing larger areas such as top plates and it can be used effectively in attics without pre cleaning the surface since it will cover and stick to almost everything. When spray foams are utilized, the installers must wear protective equipment and make certain that the area has adequate ventilation in accordance with the manufacturer's recommendations.

Duct sealing must be completed with commercially available latex mastic (preferred) or butyl backed aluminized tape. Duct tape or aluminum tape is **NOT** an acceptable product.

In all instances, use only appropriate, high quality air sealing techniques and products that are durable and fulfill their intended use and meet applicable building codes.

Dense pack insulation can be a very effective air sealing measure because its effect is twofold: it both stops air movement and reduces conductive losses by increasing the R value. In addition, dense pack insulation can be installed in areas that may be difficult to access in other ways. Generally, dense pack insulation can be installed anywhere a contractor can drill a hole, insert a fill tube and pack a cavity space at a density between 3.5-4.5 lbs/cubic foot for cellulose insulation or 2.2-2.5 lbs/cubic foot for Owens Corning PROPINK L77 and/or Johns Mansville Spider brand fiberglass or their equivalent.

Multifamily homes present many air sealing opportunities. Blower door test readings may be difficult to evaluate and tests that are conducted on individual units within a multifamily building can be misleading because some leaks can occur between units rather than to the outside and it may be difficult to determine which leaks are effective to repair. It also may be impossible to arrange with all the occupants of a multifamily to conduct a blower door test on the entire building. However, multifamily buildings generally have significantly larger air sealing needs than smaller single family buildings. Plumbing and chimney chases tend to be larger; many contain large, visible leaks and chaseways in the attic. Many tend to be older and contain construction details that include leaking key junctures. Some buildings are in very poor repair. Many are balloon framed, both on the outside walls and the central bearing partition. Because of the large leakage potential, it is crucial that the WAP Auditor thoroughly evaluate the air sealing needs and make a complete visual inspection whether a blower door is used or not. Auditors must specify areas to be addressed as part of the work order. DHCD strongly recommends the use of the blower door on multifamily buildings primarily as a tool to identify all cost effective air sealing opportunities.

Air sealing efforts in multifamily buildings must be directed at large bypasses that lead to the attic, attic top plates, series leaks, identifying and sealing key junctures, ductwork leakage, and repairing any obvious direct leaks to the outside that are in the living space (i.e. broken or missing glass, holes in the walls, fireplaces with no or ill-fitting dampers).

Blower door directed air sealing should be a systematic approach to reducing the infiltration rate in a building as cost effectively as possible. It is important that contractors not spend a lot of time sealing small, inconsequential leaks. WAP Auditors and contractors must understand the concepts of air sealing, and implement an effective protocol on each home weatherized. Close coordination and communication between the auditor and the contractor can ensure implementation of the desired goals. Seal large, cheap to fix leaks in the most important areas first (the attic and key junctures).

Use the blower door to determine the infiltration rate of the building, if suspected areas are actually leaking and use it often during the job to check the effectiveness of the work completed. Spend the time and effort necessary to **effectively** air seal the home, reduce the infiltration rate and increase client comfort, energy savings, and the effectiveness of the insulation installed as well as ensure health and safety of the occupants.

CONDUCTING A SINGLE-POINT BLOWER DOOR TEST

A. Prepare the House

Perform a walk-through inspection of the home. Pick a door to the outside (or a reasonably open unheated porch) that will be free of obstructions within at least a couple feet of the fan outlet. Close all windows (including storm windows) and lock sash locks. All doors to interior rooms should be open. The home should be set up the way the homeowner would typically have it on a winter day. Turn the heating system off. The best way to do this is to turn off the Serviceman, or Customer Emergency Switch. If neither is available turn the thermostat down as low as it will go. If there is a gas-fired domestic hot water heater turn the gas valve to pilot position. Do not turn to OFF. If the home has a fireplace with doors, close the doors tightly. If no doors exist and there are ashes in the firebox, first be certain that they are not hot. The ashes then can be covered with dampened newspaper to be certain that they are not blown into the living space. If the home has a woodstove, be certain that it is not operating, and close the doors as tightly as possible. If the stove is warm you will not be able to take a depressurization test of the home. Many in the energy field believe it is a best practice to complete a test first with the door to the cellar open and then with it closed.

B. Set up the Blower Door

Set up the Blower door according to the manufacturer's instructions in the appropriate opening. The door and its components must be in good condition. Pressure taps must be intact and not damaged. Damaged equipment must be replaced to ensure accurate readings. Be certain that hoses are connected and run to the appropriate pressure taps and locations according to the manufacturer's specifications.

If using the Energy Conservatory Minneapolis Blower Door with the DG-3 or BD DEP700 digital gauges, refer to their *Quick Guides*:

<http://www.energyconservatory.com/download/bdquickgd1.pdf>

<http://www.energyconservatory.com/download/bdquickgd7d.pdf>

If using the Retrotec Blower Door and Digital Gauge DM 2 Product Guide refer to:

<http://retrotec.com/Portals/0/Product%20Documents/QuickGuide-DM2MkII.pdf>

If using the Infiltec Blower Door, information can be found here:

<http://www.infiltec.com/inf-catb.htm>

C. Conduct the Single-Point Blower Door Test

Each Blower door manufacturer and the gauge package provided with the door have slightly different protocols for zeroing out the gauges and/or providing a baseline building pressure. The manufacturer's

protocol for setting up the gauge package properly establishing a baseline, must be completed prior to conducting the test.

After the baseline is established, remove the cover(s) of the fan. Depending on the leakage rate of the house, flow restriction protocols may need to be used. Consult the manufacturer's instructions for appropriate ranges. Turn the fan on and slowly increase the house pressure until it stabilizes at 50 Pascal. If unable to reach 50 Pa in what appears to be a relatively tight (normal) building, check for any unintended openings to the outside. If the pressure reading drops off quickly while increasing the flow, it is possible that a door has opened somewhere in the house. When the depressurization stabilizes at 50 Pa, use the appropriate gauge reading to determine the cubic feet per minute (cfm) of air flow.

D. Finishing the Blower Door Test

When all testing is completed, including determining the infiltration rate and locating the major air leaks, be certain to restore the home to its original condition. Replace any furniture that may have been moved. Turn the heating system and water heater back on. Make sure pilot lights are on and heating systems and DHW heaters are operating properly before leaving the home. Restore any woodstove or fireplace to its original condition.

WEATHERSTRIPPING WINDOWS

1. Requirements:

Only extremely loose or drafty movable prime windows which separate conditioned from unconditioned spaces should be weatherstripped.

2. Material Standards:

Although DOE sets the standard for weatherstripping at "commercial availability," DHCD requires the installation of a permanent weatherstripping product that has a minimum effective life of ten (10) years. Vinyl pre-molded v-strip Schlegel 512 or 524 or their equivalent or spring metal for double-hung-type windows and gasket-type weatherstrip for metal basement windows.

3. Installation Standards:

Weatherstripping must be installed so as to effectively seal the window when closed and latched, but still allows the window to operate properly. The fold of the weatherstripping should be to the inside of the window. Weatherstripping must be continuous along any service and may not be pieced. Adhesive backed weatherstripping must be mechanically fastened in place. Weatherstripping must be installed to effectively seal air leaks but the window must still operate easily. Stationary or fixed windows must be thoroughly caulked.

When required, a sash lock must be installed so as to hold sashes tightly together. Side locks must hold lower sash in place when engaged.

NOTE: Windows can often be tightened most efficiently simply by adjusting the stops and installing a good sash lock. Side locks are also an efficient alternative to weatherstripping.

WEATHERSTRIPPING DOORS

1. Requirements:

Doors which lead from a conditioned to an unconditioned space, such as basements, attics, or hallways are to be weatherstripped when needed.

2. Material Standards:

Although the DOE sets the standard for weatherstripping at "commercial availability," DHCD requires the installation of a permanent weatherstripping product that has a minimum effective life of ten (10) years. Door weatherstripping must be a rigid metal or wood with a flexible vinyl or silicone weatherstrip. Schlegal, Q-Lon, Amesbury or equal.

3. Installation Standards:

Weatherstripping should be installed on the door stop. Door must close properly without binding. The door sweep must be installed so as to seal the bottom of the door completely when closed and allow door to open and close without dragging. If auto sweep is used the peg screw must be adequately fastened to the jamb.

PRIORITY 1a: PRIMARY HEATING SYSTEM WORK

Heating system work completed with WAP funds must comply with the following guidance and must be charged to the appropriate categories, properly itemized, and reported on the Building Weatherization Report (BWR). Heating system work, when necessary, is Priority 1a in the WEATHERIZATION MANDATORY PRIORITY MEASURES and must be completed before advancing to subsequent priority measures.

Heating system measures must be included in the Energy Conservation (E.C.) maximum of \$10,000. Subgrantees must insure that they do not exceed the HEARTWAP allowable maximum expenditure for any measure on an individual job basis. The maximum for heating system repairs is \$600, including any expenditure in the Health and Safety Repair category.

All heating system work must be closely coordinated with the HEARTWAP to insure that clients do not receive duplicative assistance from more than one funding source. In addition, if both WAP and HEARTWAP are involved in a heating system service, the subgrantee must ensure that no contractual maximum expenditure levels are exceeded by the combined resources of the two programs.

Heating System Replacements and Asbestos Abatement should be performed with HEARTWAP funds except in very rare cases. Heating System Replacements, including Space Heaters, and Asbestos Abatement can be completed with WAP funds only with prior DHCD approval.

Subgrantees should utilize WAP and HEARTWAP funds in such a manner as to insure that the greatest number of eligible clients will receive heating system assistance. Subgrantees must also insure that they provide a cost effective retrofit package consisting of heating system and building shell measures to all dwelling units which receive assistance. DHCD strongly encourages subgrantees to leverage landlord contributions, utility funds, CDBG, and any other supplemental funding to ensure that each building weatherized receives a comprehensive package of energy conservation measures.

Technical, administrative and programmatic standards and requirements regarding heating system measures as mandated in the most current "HEARTWAP Guidance", are applicable to WAP funded heating system work. Subgrantees which administer both WAP and HEARTWAP may utilize HEARTWAP procured and approved heating contractors. Those WAP Subgrantees that do not administer HEARTWAP must procure heating system contractors consistent with the DHCD Procurement requirements.

ALLOWABLE HEATING SYSTEM MEASURES

1. For eligible homeowners or tenants with WAP eligible landlord:

- Clean/tune and evaluate (CTE), (maximum: \$125). Report as an Energy Conservation Measure.
- Burner replacements due to inefficiency, unsafe or inoperable, (maximum: \$400). Report as an Energy Conservation Measure.
- Heating System Repairs (maximum: \$600). Report as Repairs.

- Allowable Retrofit Measures, (maximum: \$500). Report as an Energy Conservation Measure. Limited to the specific list of retrofit measures in the HEARTWAP Guidance.
- Space Heater Service (maximum: \$100). Report as an Energy Conservation Measure.
- Primary heating system replacements (maximum \$2,500, FWA: \$2,750 FHW \$3,000 Steam)

2. For Tenants with individual heating systems in any size multi-family building:

- CTE to improve efficiency (maximum: \$125). Report as an Energy Conservation Measure.
- Burner Replacement for reasons of efficiency only (maximum: \$400). Report as an Energy Conservation Measure. If unsafe or inoperable, the landlord must replace or make safe.
- Heating System Repairs are the responsibility of the property owner. WAP funds cannot be used to make repairs to the heating system.
- Allowable Retrofit Measures (maximum: \$500). Report as an Energy Conservation Measure. Limited to the specific list of retrofit measures in the HEARTWAP Guidance.
- Space Heater Service, (maximum: \$100). Report as an Energy Conservation Measure.
- Primary heating system replacements (maximum \$1,000 unless property owner is income eligible)

3. For any size multi-family building with a common heating system:

- CTE to improve efficiency (maximum: \$125*). Report as an Energy Conservation Measure.
- Burner Replacement for reasons of efficiency only (max. \$400*). Report as an Energy Conservation Measure.
- Heating System Repairs are the responsibility of the property owner.
- Retrofit Measures (maximum: \$500). Report as an Energy Conservation Measure. Limited to the specific list of retrofit measures in the HEARTWAP Guidance.
- Primary heating system replacements

* For commercial sized heating systems in multi-family homes, consult DHCD for additional funds, if needed, for the various heating system measures.

OIL-FIRED HEATING SYSTEMS: **MEASURES**

The following measures are allowable within the maximum allowable cost per dwelling unit:

1. CLEAN / TUNE / EVALUATE (CTE)

A CTE shall include the following measures:

- Check for oil leaks
- Check chimney base and flue pipe
- Check operation of all controls
- Check pump pressure
- Check barometric damper operation
- Check thermostat operation
- Flush low water cut-off
- Lubricate all Motors
- Replace all filters as necessary
- Clean or change water glass
- Clean pump strainer and inner housing
- Replace nozzle
- Clean electrodes
- Clean, brush and vacuum boiler and furnace thoroughly
- Adjust fuel/air for proper combustion
- Document major code violations

Combustion efficiency test results are required as part of CTEs.

Every attempt should be made to optimize the firing rate on oil-fired equipment when possible.

2. **REPLACEMENT OIL BURNER:** a flame-retention head device which atomizes the fuel oil, mixes it with air and ignites the fuel-air mixture.
3. **CLOCK THERMOSTAT:** a device which is designed to reduce energy consumption by regulating the demand on the heating system in which it is installed and uses:
 - A. A temperature control device for interior spaces incorporating more than one temperature control level; and
 - B. A clock or other automatic mechanism for switching from one control level to another.
4. **HYDRONIC BOILER CONTROL:** A modulating aquastat which closely matches the outside temperature with the BTU requirements of the home and adjusts the circulating boiler water temperature accordingly.
5. **REPLACEMENT FURNACE OR BOILER:** The space heating system which provides for the majority of the space heating needs of the residents.

OIL-FIRED HEATING SYSTEMS: **SETTING PRIORITIES**

1. Clean/Tune/Evaluate:

If a burner has not been serviced within the current heating season, or if any of the combustion efficiency test results are unacceptable, then this option must be considered no less than priority number 1a.

2. Replacement Oil Burner:

A burner may not be considered for replacement unless (a) a licensed technician states in writing that the existing burner is unsafe or inoperable, or (b) the combustion efficiency of the burner, after a tune-up evaluation, is 72% or less. Under these circumstances, the priority ranking of this option must be equal to priority number 1a.

3. Clock Thermostat:

After all applicable measures have been installed and allowable funds are available, this measure should be considered as an alternative. However, no savings will be realized unless the occupant utilizes the device in accordance with its intended purpose.

4. Hydronic Boiler Control:

After all applicable measures have been installed and allowable funds are available, this measure should be considered as an alternative.

5. Replacement Furnace or Boiler:

If a furnace or boiler is documented to be unsafe, inoperable or inefficient or if it is a gravity warm air furnace then it should be placed at the top of the priority list. All heating system replacements should only be performed with HEARTWAP funds, unless DHCD prior approval is granted.

6. Other allowable heating system measures, which, if applicable, must be performed in conjunction with any other necessary heating system modification:

- Line Voltage or Low Voltage Thermostat.
- Combustion Chambers: must be rebuilt, relined, replaced or otherwise modified if they are found to be significantly deteriorated or if they are improperly sized. DHCD recommends the use of pre-cast mini-combustion chambers and wet chamber lining material (wet pack).
- Thermostatic Radiator Valves: provide individual control of radiators, convectors or baseboards in two pipe steam and hot water heating systems. They effectively allow for the balancing of uneven heat distribution systems.
- Air Ducts and Connectors: must be properly sized and able to deliver heat to the desired areas. Sufficient cold air return should be present, equal to 100% of the warm air distribution. Seams of the ductwork and connectors must be adequately sealed.

OIL-FIRED HEATING SYSTEMS: PERFORMANCE STANDARDS

1. Clean/Tune/Evaluate (CTE) Performance Standards:

The following combustion efficiency test results are considered acceptable for oil-fired heating systems after a CTE has been performed.

• Smoke	0 to Trace
• Net Stack Temperature	300 to 600°
• Net Stack Temperature with	300 to 400°
• Flame Retention Burner	
• CO 2	8 to 12%
• O 2	4-8%
• Carbon monoxide	less than 100 ppm in flue
• Draft at Breach	-.02 to -.04
• Draft over Fire	-.01 to -.02

Note: The use of “soot sticks” is not an acceptable alternative brushing and vacuuming the heat exchanger surface.

If post combustion efficiency test results are found not to be within acceptable parameters, then the attending technician should be required to document the heating system's deficiencies.

2. Burner Replacement Performance Standards:

Oil Burners replaced in coal converted boilers or furnaces must attain a minimum combustion efficiency of 75% with a zero to a trace of smoke.

Oil Burners replaced in design boilers or furnaces must attain a minimum combustion efficiency of 79% with a zero to a trace of smoke.

DHCD staff members are the only individuals authorized to grant a waiver of the above standards.

3. Furnace or Boiler Replacement Performance Standard:

Oil-fired furnace or boiler replacements must attain a minimum post-installation combustion efficiency of 80% with a zero to a trace of smoke.

OIL-FIRED HEATING SYSTEMS: QUALITY CONTROL PROCEDURES

1. Take a combustion efficiency and carbon monoxide test.
2. Check for unusual noises and vibrations.
3. Check the flame ignition. Flame ignition should be instantaneous. Delayed ignition is indicative of a combustion problem.

4. Check for flame impingement. Flame should fill the combustion chamber without hitting the sides or back of the chamber.
5. Check the flame cut-off time. The flame should cut off in less than three seconds after the burner shuts off.
6. Check for soot deposits in the flue, combustion chamber, and on the heat exchanger.
7. Check the chimney for problems and the accumulation of soot.
8. Check for oil leaks.
9. Check the draft regulator for any improper adjustments or defects.
10. Check the distribution system.
11. Check for the presence of a Hartford Loop (New Steam Systems only)

The acceptable parameters of a combustion efficiency test on oil fired equipment are as follows:

Net stack	300-500° F
Smoke	0-Trace
CO ₂	8-12%
O ₂	4-8%
Draft	.02-.04

The maximum allowable concentration of carbon monoxide (CO) in the flue gas is 100 parts per million. The goal is to have no CO in the flue gas. The ambient air in the area around the appliance shall have no greater than 9 ppm CO.

GAS-FIRED HEATING SYSTEMS: **MEASURES**

The following measures are allowable within the maximum allowable cost per dwelling unit.

DEFINITIONS:

1. **CLEAN/ TUNE/ EVALUATE (CTE):**

A CTE shall include the following measures:

- Pilot and burner adjustment
- Adjustment of ventilation and combustion
- Check and reset controls
- Replace all filters as necessary
- Lubricate motors
- Flush low water cut-off (steam)
- Check operation of steam and water relief valves
- Check thermostat operation
- Check safety valve
- Check thermocouple - replace if necessary
- Combustion efficiency test
- Documentation of major code violations

2. **CLOCK THERMOSTAT:** A device which is designed to reduce energy consumption by regulating the demand on the heating system in which it is installed and uses:

- A. A temperature control device for interior spaces incorporated more than one temperature control level;
and
- B. A clock or other automatic mechanism for switching from one control to another.

3. **HYDRONIC BOILER CONTROL:** A modulating aquastat which closely matches the outside temperature with the BTU requirements of the home and adjusts the circulating boiler water temperature accordingly.

4. **POWER BURNER:** A burner in which either gas or air or both are supplied at a pressure exceeding, for gas, the line pressure, and for air, atmospheric pressure; this added pressure being applied at the burner.

5. **REPLACEMENT FURNACE OR BOILER:** The space heating system which provides the majority of the space heating needs of the residents.

GAS-FIRED HEATING SYSTEMS: **SETTING PRIORITIES**

1. Clean/Tune/Evaluate:

If the flame is yellow instead of blue or if after performing a combustion efficiency test the steady-state efficiency is below 75%, then this option must be considered no less than priority number 1a.

2. Clock Thermostat:

After all applicable measures have been installed and allowable funds are available, this measure should be considered as an alternative measure. However, no savings will be realized unless the occupant utilizes the device in accordance with its intended purpose.

3. Hydronic Boiler Control:

After all applicable measures have been installed and allowable funds are available, this measure should be considered as an alternative measure.

4. Power Burner:

This modification should be utilized, when possible and appropriate, to replace inefficient (72% or less efficiency after a tune/clean/evaluate), unsafe, or inoperable atmospheric conversion burners in former oil or coal furnaces or boilers.

5. Replacement Furnace or Boiler:

If a furnace or boiler is documented to be unsafe, inoperable, inefficient or if it is a gravity warm air furnace then it should be placed at the top of the priority list. All heating system replacements should only be performed with HEARTWAP funds, unless DHCD prior approval is granted.

6. Other allowable heating system measures, which, if applicable, must be performed in conjunction with any other necessary heating system modification:

- Line Voltage or Low Voltage Thermostat.
- Combustion Chambers: must be rebuilt, relined, replaced or otherwise modified if they are found to be significantly deteriorated or if they are improperly sized. DHCD recommends the use of pre-cast mini-combustion chambers and wet chamber lining material (wet pack).
- Thermostatic Radiator Valves: provide individual control of radiators, convectors or baseboards in two-pipe steam and hot water heating systems. They effectively allow for the balancing of uneven heat distribution systems.
- Air Ducts and Connectors: should be properly sized and able to deliver heat to the desired areas. Sufficient cold air return should be present, equal to 100% of the warm air distribution. All duct work seams must be adequately sealed.

GAS-FIRED HEATING SYSTEMS:
QUALITY CONTROL PROCEDURES

1. Check the start-up sequence of the appliance.
2. Check the color of the flame. The flame should be blue. A small amount of orange indicates impurities in the gas and is acceptable. A yellow or white flame indicates insufficient combustion air and the likelihood of carbon monoxide production.
3. Check the flame for stability. The flame should be stationary on the burners, not “dancing”.
4. Check for unusual noises and vibrations.
5. For gas conversion units, check for a defective or improperly adjusted draft regulator.
6. Take a combustion efficiency, carbon monoxide, and draft test.
7. Check the distribution system.
8. Check for the presence of a Hartford Loop (new Steam Systems only)

The acceptable parameters of a combustion efficiency test on gas-fired equipment are as follows:

Net stack	300-500 ⁰ F
Smoke	0
CO ₂	7-9%
O ₂	4-10%
Draft	.02-.04

The maximum allowable concentration of carbon monoxide (CO) in the flue gas is 100 parts per million. The goal is no CO in the flue gas. The ambient air in the area around the appliance shall have no greater than 9 ppm CO.

HEATING SYSTEM EFFICIENCY REPORT

CLIENT NAME: _____ Job # _____

System type: Oil _____ Gas _____ Design _____ Converted _____ Gravity _____ FHW _____ FWA _____ Steam _____ Space Heater _____

Initial Efficiency Test Results	Service Technician's Test Results	Final Efficiency Test Results
Gross Stack Temp. _____	Gross Stack Temp. _____	Gross Stack Temp. _____
Net Stack Temp. _____	Net Stack Temp. _____	Net Stack Temp. _____
Smoke _____	Smoke _____	Smoke _____
CO2/O2 _____	CO2/O2 _____	CO2/O2 _____
Carbon Monoxide _____	Carbon Monoxide _____	Carbon Monoxide _____
Overfire Draft _____	Overfire Draft _____	Overfire Draft _____
Breech Draft _____	Breech Draft _____	Breech Draft _____
Efficiency _____ %	Efficiency _____ %	Efficiency _____ %
Comments: _____	Nozzle Size (Oil and Kero) _____	Comments: _____
_____	Comments: _____	_____
_____	_____	_____
_____	_____	_____
Signature _____	Signature _____	Signature _____
Date _____	Date _____	Date _____

PRIORITY 2: UNINSULATED ATTIC/ ATTIC INSULATION

ATTIC INSULATION

1. Definition:

A material or assembly of materials that is primarily designed to resist conductive heat loss, which is installed between the conditioned area of a building and an unconditioned attic. Where the conditioned area of a building extends to these roofs, the term attic insulation also applies to material used between the underside of the roof and the ceiling.

2. Requirements:

- A. Insulate all finished and unfinished attic areas, where possible, to a settled density (S.D.) of R-38 or R-49 depending on the housing type or fuel source. (See the Weatherization Mandatory Priority Measures chart). Batt type insulation may be used when appropriate. The Weatherization staff should use some discretion as to what level to add attic insulation. Since the greatest conservation impact of added insulation is generally in the first few inches of insulation, in some homes, it would make sense to insulate the attic to R-19 - 22 and use the differential in cost to address uninsulated walls depending on available funds.
- B. Properly insulate and weatherstrip all attic entryways, such as: scuttle holes (minimum R-19), walkup stairways (R-5), and pull down stairways (R-10 minimum / Thermodome or equivalent whenever possible).
- C. Complete and retain on file an Attic Inspection Form for all attic insulation installations.
- D. After completing installation of thermal insulation materials, the crew chief or private contractor responsible for the installation must complete and post a "Certification of Insulation" form adjacent to the electrical fuse box.

3. Procedures:

Pre-installation procedures (attic preparation):

- A. Identify all recessed lighting fixtures, including wiring, compartments, ballasts, vents, chimneys and other heat-producing devices in all areas where insulation is to be installed.
 - (1) Insulation must be kept no less than 3" from any non-IC rated recessed light fixture and no insulation shall be installed above. A physical barrier must be installed no less than 3" from the fixture and must be taller than the insulation to be installed. If the fixture is accessible, an air tight box may be installed to limit air leakage. The box must be sized to provide the required clearance from the fixture, with sides taller than the insulation to be installed and a non-insulating moisture permeable top of gypsum board or equivalent material. The gap between the fixture and ceiling may be sealed with an appropriate caulking or joint compound.
 - (2) Insulation must be kept no less than 3" around any heat producing chimney or vent. Air sealing of these areas must be completed using only non-combustible materials and sealed with an ASTM rated 136 material. A non-combustible physical barrier must be installed higher than the insulation.

780 CMR 5808 INSULATION CLEARANCE

5808.1 Combustible Insulation. Combustible insulation shall be separated a minimum of three inches (76mm) from recessed light fixtures, fan motors and other heat-producing devices.

Exception: When heat-producing devices are listed for lesser clearances, combustible insulation complying with the listing requirements shall be separated in accordance with the conditions stipulated in the listing.

- B. Inspect the room, ceiling, and attic floor to identify areas where a previous moisture problem caused paint peeling, warping, staining, visible fungus growth, rotting or other structural damage. Do not install insulation in such areas until the resident is informed and these conditions are corrected and their sources eliminated.
- C. Inspect the ceilings to insure that they will carry the weight of the insulation. Installing fiberglass batt type insulation may be an acceptable alternative in those areas where the weight of a blown insulation may be a concern.
- D. Determine if knob and tube wiring is present (see Knob and Tube Wiring guidance).
- E. Install permanent blockings to restrain loose-fill insulation from clogging soffit vents at the eaves restricting attic ventilation. Install permanent blocking to ensure free movement of air through soffit vents into the attic, to prevent ventilation air from “air washing” the insulation, and to achieve a uniform R-value and complete coverage over the exterior wall.
- F. Air seal open wall and drop ceiling cavities to prevent filling these areas with insulation. **Comprehensive targeted attic air sealing consistent with the Blower Door Directed Air Sealing priorities of this manual must be completed prior to adding attic insulation to reduce air leakage into the attic and ensure the effectiveness of the insulation.** Additionally, the installer must use discretion installing loose fill insulation in the area of a whole house fan or around duct work that may be present in the attic. Batt type insulation may be recommended in these areas.
- G. All attic accessways, either in kneewalls or ceilings, must be installed so that they may be readily removed for post inspection purposes by subgrantee or grantee personnel. In those few cases where this practice would not be practical the subgrantee must ensure that the area insulated is inspected by an appropriate subgrantee representative prior to the permanent sealing of such accessway. This may be the case when a roof or gable end vent opening is utilized as access to an attic or ceiling area. **The subgrantee must document the results of the in-process inspection.** If for any reason the subgrantee is unable to inspect any area of an attic, the contractor must provide photographic documentation of the work that was completed.
- H. Permanent damming must be installed around all attic access ways in a manner that will not interfere with opening the access cover and that when opened, will prevent insulation from falling into the living area. The insulation surrounding the dam must be equal to the R-value to the remaining attic space.

Pull-down stairway covers: Thermadome, a site-built equivalent, or other commercially available products should be utilized whenever possible. A site-built box must be constructed with minimum 2 inch foil-faced foam; all seams sealed. The attic floor must be prepared and leveled to accommodate

the Thermadome or insulated box. Velcro or a similar fastening system must be utilized to fasten the box onto an appropriate weatherstripping material to minimize air leakage at the edges of the box. In those instances where a Thermadome or equal can not be installed due to structure constraints, an insulated quilt (Appropriate Technology Window Quilt or equal) may be used to provide some insulation value and reduce air leakage through the pull-down stairway.

VENTILATION REQUIREMENTS

Do not install insulation in an attic space unless adequate and permanent ventilation is installed.

Adequate cross-ventilation shall be maintained above all attic insulation by providing both low and high vents or gable end vents. One square foot of net-free vent area (NFA) shall be provided for every 300 ft² of attic area ideally with 50 to 60% of the vent area located near the roof ridge and 40 to 50% located near the eaves. One level of venting may be used provided that adequate cross ventilation can be maintained.

The energy auditor must specify the type number, and location of all vents to the contractor.

NOTE: Although the use of window vents is allowed, the vents must be permanently fixed and must meet the minimum requirements for free vent area as noted above.

VENT PLACEMENT STANDARDS

Vents should be placed so as to eliminate "still" air pockets in the attic. This may be accomplished by distributing the lower vents as widely as possible. Vents should be equally spread to address all attic areas in compliance with the above formulas.

All vents must be screened. Large "can" type roof vents (144 square inches free air) should not be utilized as low-venting where snow may be of concern. The use of active turbine type vents is not recommended in most circumstances as they can create high negative pressures in the attic area causing higher exfiltration from the living space into the attic.

In slate or clay tile roof applications, a combination of gable-end and soffit vents should be used when possible.

All vents shall be installed using manufacturer's recommendations. Holes should be cut to provide a free opening at least equal in size to the opening in the ventilator. There should be no obstructions in the line of the vent opening (be sure to cut and place vents so as to avoid rafters and other structural components). Low vents should be placed a minimum of one foot above the level insulation will be blown. Soffit vents and other low vents, which would cause blowing of loose fill insulation, should be provided with adequate baffling so as to deflect air above the surface of the attic insulation to prevent "air washing" and to prevent blockage of the vents. All necessary precautions should be taken to insure a watertight installation. Roofing should overlap the roof vent flashing at top and sides, when possible.

Attic Inspection Form
Mandatory for all Attic Insulation Jobs

Client Name: _____ Job #: _____

Date: _____

Section A: To be filled out by the WAP Auditor during the initial interview with the client.

Are there any recessed light fixtures in this dwelling?

Location:

Yes _____ No _____ Don't Know _____

Section B: To be filled out by the auditor upon visual inspection of the ceiling area beneath the attic.

1. Recessed Lighting Fixtures

2. Other potential heat producers

Section C: To be completed by the Insulation Contractor at the time of the installation.

Number of recessed lights: _____
Furnace Flues: _____
Other Heat Producers: _____
Total Guards Needed: _____

Should agree with Section B.

Section D: To be signed by the insulation contractor after completion.

I have installed _____ insulation guards.

Signed: _____

Subgrantee/Company: _____

Date: _____

Section E: To be signed by the weatherization client.

I agree that the number of insulation guards indicated have been installed as noted above. I have received the notice to the client that was attached below.

Signature: _____ **Date :** _____

(DETACH HERE AND GIVE TO CLIENT)

Notice to Weatherization Clients: The purpose of insulation guards is to ensure that your dwelling is in compliance with the National Electric Code. The insulation used meets all Federal test specifications. However, since insulation retains heat, it is essential that heat producing sources be protected. For this reason, it is important that insulation guards not be removed, altered or covered. Be sure to use insulation guards if you install new recessed light fixtures or some similar fixture. Also be certain not to obstruct any attic ventilation devices.

CERTIFICATE OF INSULATION

Part 1 - General

Address of Residence:

Name and Address of Contractor:

Date of Installation:

Part 2 - Areas Insulated

WALLS (_____ Sq. Ft.)

CEILINGS (_____ Sq. Ft.)

FLOORS (_____ Sq. Ft.)

Type of Insulation:

Type of Insulation:

Type of Insulation:

Manufacturer:

Manufacturer:

Manufacturer:

R-Value Installed	Amount Installed (# Bags)
10	10
15	15
20	20
25	25
30	30
35	35
40	40
45	45
50	50
55	55
60	60
65	65
70	70
75	75
80	80
85	85
90	90
95	95
100	100

R-Value Installed	Amount Installed (# Bags)
10	10
15	15
20	20
25	25
30	30
35	35
40	40
45	45
50	50
55	55
60	60
65	65
70	70
75	75
80	80
85	85
90	90
95	95
100	100

**R-Value Installed Amount Installed
 (# Bags)**

Part 3 - Certification

I, _____, certify that the residence identified in Part 1 was insulated as specified in Part 2 and the installation was conducted in conformance to applicable Codes, Standards, and Regulations.

Signature

This Certificate must be completed and prominently posted adjacent to the electrical panel.

PRIORITY 3: UNINSULATED WALLS/ SIDEWALL INSULATION

SIDEWALL INSULATION

1. Definition:

A material designed to resist conductive heat flow, and to reduce infiltration which is installed within wall cavities between conditioned and unconditioned areas within the structure, or conditioned areas and the outside.

2. Material Standards:

Thermal insulation materials used to insulate sidewall cavities shall conform to those listed in the Appendix A, Standards For Weatherization Materials. The material used in retrofit wall insulation jobs must be capable providing a “dense pack” that provides adequate infiltration reduction. For example, cellulose installed at 3.4-4 lbs/ft³ or 2.2-2.5 lbs/ ft³ for Owens Corning PROPINK L77 and/or Johns Mansville Spider brand fiber glass or equivalent.

3. Inspection and Installation Guidelines

A. Determine the amount of existing insulation:

- Ask the resident if sidewall insulation has been previously installed into the structure.
- Inspect the wall surfaces for evidence of drilling, plugging or removal of the siding materials.
- Use an infrared scanner to ascertain the existence of existing wall insulation.
- Remove the cover plates for electrical wall outlets/switch plates and examine the cavities for evidence of insulation. Remember to interrupt the electrical current to that area before probing.

If insulation is found in a cavity, determine to what extent the insulation work has been completed throughout the structure.

B. Inspect the Structure for Evidence of Moisture Damage (i.e., peeling paint, warpage, visible stains, fungal growth, rot, or other structural damage). If evidence of moisture damage is determined:

- Inspect the gutter/downspout system, siding, and roofing materials, drainage around foundations, and the basement/ crawlspace area for conditions indicating excessive external moisture infiltration.
- Determine if occupant behavior, the structure's size or its construction is causing excessive amounts of internally produced moisture.

Conditions that may contribute to excessive internal moisture generation include:

- A living area of less than 800 sq. ft.

- Less than 250 sq. ft. of living space per occupant.
- Tight wall and ceiling construction with thorough leakage sealing completed throughout the structure.
- Electrically heated homes or homes with a heating system utilizing outside combustion air.
- Homes that are humidified during the winter.
- Clothes dryers vented into the living space.
- Dirt floored crawlspaces with no vapor barrier.

Locate the source of severe moisture conditions and correct them prior to installing sidewall insulation.

Determine, after exploring all reasonable alternative corrective actions, if the installation of a mechanical ventilation device (exhaust fan) will adequately control the severe moisture condition(s). Exhaust fans are to be charged to the Health and Safety category.

C. Inspect the Interior Walls for Structural Integrity

Examine areas and conditions which might allow insulation to escape into the living space, including pocket doors, balloon construction details (i.e., openings at the top plate, sill plate, and second story ceiling joists), unbacked cabinets and closets, ducts running through exterior walls, as well as interior and exterior wall surface integrity, such as visible cracks, holes, unbacked paneling, etc.

Determine whether those conditions will allow insulation to escape and whether they can be adequately corrected. If the conditions cannot be corrected, determine if the specific area can be left uninsulated without drastically reducing the thermal performance of the entire retrofit.

D. Inspect the Electrical Service

Determine whether the wiring runs through the exterior wall cavities and note the conditions of that wiring where it is visible.

Note the wire gauge and ensure that circuit protectors are matched to the appropriate wire size. The following protection is required:

- 15 AMP for #14 Wire
- 20 AMP for #12 Wire

If active knob and tube wiring is present in sidewall cavities, no insulation can be installed in that cavity. Consult the Knob and Tube Guidance for further information.

If the condition of the wiring cannot be corrected and, determine if the specific cavities containing wiring can be left uninsulated without drastically reducing the thermal performance of the entire retrofit. Do not complete the retrofit if the conditions cannot be corrected or if specific cavities cannot be left uninsulated without drastically reducing cost-effectiveness.

E. Inspect the Routing of the Mechanical Services

Locate and note the pathways that plumbing, wiring, heat runs, air return runs and gas lines take through the exterior walls. Take steps to assure that the installation of insulation will not damage or in any way hinder the normal function of those services. In some cases, cavities or groups of cavities may have to be left uninsulated. Determine if the specific area can be left uninsulated without drastically reducing the thermal performance of the entire retrofit.

F. Inspect the Exterior Siding

Determine if the siding is of a type that can be loosened or removed in a safe and efficient manner. Siding must be unlocked/removed unless the homeowner gives prior written permission to drill and plug them.

If asbestos cement sidewall shingles are present, all work must be completed consistent with DHCD Information Memorandum WAP-IM-2010-026: DHCD/MassDEP Asbestos Cement Shingle Guidance dated December 30, 2010.

Inspect for missing or damaged siding and other conditions that would allow insulation to escape from and/or precipitation to enter into exterior wall cavities.

Document with notations and/or pictures any existing siding problems.

4. **Installation Procedures:**

A. Pre-Installation Procedures

1. Ensure that the moisture conditions detected in the structure during the course of the initial inspection are corrected prior to insulation of the sidewall cavities. This may be accomplished by one or more of the following techniques:

- Provide a vapor barrier on the interior surface of the walls in bathrooms, kitchens, laundry rooms, and any other high moisture areas.
- Thoroughly seal all cracks and holes through the interior wall surfaces in high moisture areas.
- Install a vapor barrier and ventilation into high moisture crawlspaces.
- Correct exterior structural flaws that admit precipitation into the wall cavities, i.e., repair gutter, downspout, drainage system, and seal gaps above door/window casings.
- Install an adequate moisture control system in the attic.
- Vent clothes dryers to the outside.
- Advise the owner/occupants to lower their humidifier and/or to change lifestyle practices which contribute significantly to high humidity.

- Install an independently controlled mechanical ventilation device in high moisture living areas.
 - To the greatest degree possible, moisture problems should be mitigated at the source.
2. Ensure that all openings in sidewalls through which the insulation can escape are blocked as follows:
- Missing interior wall surfaces will be covered with a compatible material (i.e., drywall) and sealed into place.
 - Missing or damaged exterior siding on homes with incomplete or no subsiding will be replaced/repared.
 - Wall cavities with no top plate and/or open at the sill plate will be blocked and sealed with an air impermeable barrier.

Carefully locate and avoid accessing and insulating wall cavities that would either allow insulation to escape or present a hazard to the occupant, installer or the home's structural/mechanical integrity, e.g., heat ducts, recessed lights, vent fans, electrical service entrances, etc.

3. Ensure Worker and Client Safety Regarding Lead Paint. All sidewall insulation jobs on homes built prior to 1978 must be completed in accordance with the MA Division of Occupational Safety Lead-Based Paint Renovation, Repair, and Painting Program regulations (Lead RRP) by an EPA Certified and/or Mass Licensed Firm with on-site supervision of a Certified Renovator.

Detailed specifications regarding the health and safety of workers in the construction industry can be found in Construction Industry OSHA Safety and Health Standards (299CFR 1926/1910).

B. Installation Procedures

The dense-pack insulation is mandatory for all DOE weatherization sidewall insulation installations. Dense-packing insulation using a single-hole technique with the appropriate fill tube provides for superior coverage, density and significantly reduces air infiltration in wall cavities and has been identified as a “Best Practice.” Cellulose insulation must be installed at a density greater than 3.5 lbs/ft³. Blown fiberglass designed to be dense-packed in a retrofit cavity such as Owens Corning PROPINK L77 and/or Johns Mansville Spider brand must be installed at 2.2-2.5 lbs/ft³ according to the manufacturer’s specifications. To properly dense pack a sidewall, the contractor’s blowing equipment must be able to provide sufficient pressure to ensure adequate packing of the material. See the DHCD Insulation Machine Testing Protocol in the following section of this manual.

To accomplish complete coverage using this method the installer must access the wall with a single hole drilled in each cavity (i.e. through the exterior sheathing after the siding has been removed, top or sole plate, behind the baseboard or crown molding, etc.). Drilling through the exterior siding is NOT allowable except in very unusual circumstances with prior approval by the homeowner and WAP Subgrantee. Entry holes must be thoroughly probed to locate fire stops or other obstructions that may necessitate additional access holes. A flexible fill tube, of appropriate stiffness, long enough to reach to the opposite end of the cavity, must

then be inserted into the cavity and withdrawn as the cavity fills and pressurizes. It is imperative that a fill tube be used with this technique. A single hole technique without a fill tube will not provide adequate density or coverage and is not an acceptable practice in the WAP

The second method that may be used **only if the dense-pack method is not possible** involves drilling a minimum of two (2) holes per one story cavity and installing insulation. Directional nozzles may help improve density and coverage.

Access wall cavities with a minimum of two (2) holes per story with no more than 5' distance between those holes. Entry holes must then be probed to locate fire stops or other obstructions which may necessitate additional entry holes to assure the maximum pressurization practical for that cavity. This process applies to exterior siding, subsiding, and interior wall surface applications.

Follow manufacturer recommendations on air pressure settings unless it has been determined by testing that a machine's capability to pressurize a cavity has been altered by mechanical, material, or atmospheric conditions.

WAP Subgrantee Energy Auditors and Coordinators are responsible for insuring that the dense pack method is utilized to the maximum extent practical by all contractors. Waivers may be given only in limited situations and must be documented in writing and a copy must be maintained in the client file.

Close all entry holes in a professional manner using techniques and materials that ensure a complete, secure seal, with minimum damage to the accessed areas. Industry standards state that if the exterior siding is removed and replaced, the subsiding must be plugged prior to the exterior siding replacement. Tar paper, house wrap, spray foam (single or two part), plugs and ice & water shield are acceptable materials. Siding must be replaced in a professional manner.

When limited funds require that a Subgrantee insulate only a portion of all the sidewalls of a building, the auditor's decision as to which walls to insulate should be based on the following criteria:

- The level of exposure of the walls to the elements.
- The areas of the home used by the occupants.
- The direction of the prevailing winds.

The auditor should clearly state and diagram which walls are to be insulated and the contractor's invoice must provide the subgrantee with a diagram of the areas that were insulated.

C. Post-Installation Procedures

Thoroughly clean the work area and remove any debris or materials left over from the access and installation process.

Prime any wood used in closing the access holes or in other preparatory repairs that is left exposed to the weather.

Assure that the cavity access coverings are securely sealed and fastened into place.

After completing installation of thermal insulation materials, the person responsible for the installation must complete a "Certificate of Insulation" form. The "Certificate of Insulation" must be posted adjacent to the building's electrical service panel.

5. **Restrictions:**

If a contractor determines that the sidewalls of a building have previously been insulated during any installation, and no further retrofit is possible, then the reimbursement for that measure is limited to \$60 for labor expended in test drilling a minimum of four (4) sides of the building. The contractor must test drill all the walls.

A contractor always retains the right to perform an inspection of a building's sidewalls prior to accepting a job.

6. **Coverage:**

Voids of any type or size, other than those previously mentioned are unacceptable when insulating sidewall cavities. DHCD requires insulators to return and re-insulate any sidewall areas that lack adequate insulation material.

**Department of Housing and Community Development
Weatherization Assistance Program**

ASBESTOS CEMENT SHINGLE GUIDANCE:

**Contractor's responsibility regarding the removal and reinstallation of
Asbestos Cement Shingles**

Background

The Massachusetts Department of Environmental Protection's (MassDEP's) asbestos regulations (310 CMR 7.15) protect public health and environment by establishing safe handling practices for demolition or renovation activities involving asbestos. This document is intended to provide contractors, working under the Department of Housing and Community Development's Weatherization Assistance Program, guidance regarding MassDEP's asbestos regulations. The guidance applies specifically to removing and replacing intact asbestos cement shingles that are in good condition.

Before Starting the Work

Contractors must notify MassDEP on an Asbestos Notification Form ANF-001 prior to commencement of asbestos cement shingle removal.

MassDEP has issued the Department of Housing and Community Development a "Blanket Notification" which allows for contractors to begin work after filing their ANF-001 Form but without waiting for the typical 10-day notification period. Contractors should contact the Department of Housing and Community Development for the Blanket Notification number that will be needed for the Asbestos Notification Form when notifying MassDEP for individual projects.

The Asbestos Notification Form is available on MassDEP's web site at:

<http://mass.gov/dep/air/asbhom01.htm>. The easiest way to file an asbestos notification is to do it online via MassDEP's website. For additional information about online filing, go to: www.mass.gov/dep/service/compliance/edeponlf.htm. You can visit MassDEP's website or call 617-574-6888 for additional information about online filing. A notification fee is required when filing an ANF-001. **However, owner-occupied residential properties with four or fewer units, cities, towns, counties, districts of the Commonwealth of Massachusetts, municipal housing authorities and other state agencies do not have to pay notification fees.**

Handling Practices

If you plan to remove asbestos cement shingles that are in good condition you do not need to construct a sealed work area and use air cleaning provided you otherwise comply with MassDEP's asbestos regulations at 310 CMR 7.15 and you adhere to the following handling practices:

1. The asbestos cement shingles should not be broken, sanded, sawed or drilled at any time during removal or subsequent handling.
2. The asbestos cement shingles must be carefully lowered to the ground after removal to avoid breaking the shingles [see 310 CMR 7.15(1)(c) 2.b.].
3. A drop cloth must be used under the work area. MassDEP recommends that the drop cloth should be a minimum of five feet wide for buildings up to ten feet in height (1 story), and that an additional three feet in width be added to the drop cloth for each additional floor above the ten-foot level. The drop cloth should be periodically cleaned during the removal of the shingles (i.e. pick

up and properly package loose shingles) to prevent build up of debris and overflow onto the ground.

4. All doors and windows of the side of the building where the removal is taking place should be closed and locked.
5. The asbestos cement shingles must be wetted just prior to removal to minimize release of asbestos fibers to the ambient air. Mass DEP recommends that a pump-up type sprayer (“garden sprayer”) be used for this purpose. It will deliver a controlled amount of water and prevent flooding; thereby minimizing slip hazards while working on ladders and drop cloths. A cup (8 oz) of automotive windshield wash, used as a surfactant or wetting agent, should be added to each gallon of water to assist in wetting the asbestos shingles.
6. A bucket of warm soapy water should be maintained at the site for decontamination purposes. Workers hands and faces should be rinsed before any coffee or meal break. All tools should be rinsed off at the end of each workday.

Packaging, Labeling and Disposal

It is understood that the contractors intend to re-apply the same shingle that was initially removed. However, in the event shingles are broken during the removal process and cannot be re-applied, the contractor must properly package, label and dispose of the broken asbestos cement shingle(s).

1. The wetted broken shingle(s) must be placed and sealed in leak-tight containers and properly labeled [see 310 CMR 7.15(1)(e)1.a]. Mass DEP strongly recommends using cardboard boxes wrapped in two (2) layers of 6-mil poly and sealed with duct tape or fiber drums with locking lids, which ensures that the waste remains confined in a leak-tight state.
2. Uncontained asbestos cement shingles should never be bulk loaded into a truck, dumpster or trailer for transport to disposal.
3. Each container of asbestos waste must be clearly identified with an asbestos warning label in accordance with 310 CMR 7.15(1)(e)1. The label must state:

CAUTION
Contains Asbestos
Avoid Opening or Breaking Container
Breathing Asbestos is Hazardous to your Health

The name of the property owner and address of the site of generation should also be on a label on the exterior of the container.

4. Asbestos-containing waste material, including asbestos-cement shingles, are classified as a special waste under the provisions of the Massachusetts solid waste regulations, 310 CMR 19.061. Therefore, asbestos cement shingles must be disposed at a landfill that is specifically permitted to accept asbestos waste. The best option is to hire a waste hauler or asbestos abatement contractor to transport the asbestos cement shingles to a disposal facility. Many waste haulers and asbestos contractors are familiar with various disposal facilities and frequently transport wastes to out-of-state facilities permitted to accept asbestos waste. The asbestos shingles must be properly packaged and labeled during transport and delivery to the landfill. Asbestos shingles must not be disposed at a transfer station, processing/recycling facility, or municipal waste combustion facility.

INSULATION MACHINE TESTING PROTOCOL

Overview:

The primary Quality Control elements for dense pack blown insulation are in-process inspections and visual post inspections integrated with infrared scanning with the blower door. The machine test primarily assists production by improving insulation blowing efficiency. It is an activity that should be welcomed by contractors, supported by WAP Agency personnel and is not intended to be adversarial. Testing will be done by DHCD staff at least once annually for each contractor on all machines that are used for Weatherization and Utility funded programs for income eligible customers.

Process:

1. Disconnect the blowing hose from the machine.
2. Close the material feed gate so that no new material enters the airlock.
3. Place a bag around the outlet and run the blower and agitator until no more material exits the airlock.
4. Adjust the blower controls for maximum or full air.
5. At the hose outlet of the machine, press the bottom plate of the pressure gauge firmly against the outlet pipe.
6. With only the blower operating (no agitator) note the maximum pressure achieved on the gauge.
7. The pressure should be at least 80 inches H₂O or 2.9 psi.
 - A pressure lower than these numbers does not meet the industry requirements for dense pack and the machine must be serviced before being put back into service.
8. Now retest the machine with both the blower and agitator running, note the pressure range (lowest and highest fluctuations). The pressure at the lowest point should be at least 60 inches of H₂O or 2.5 psi.
 - A pressure fluctuation below this usually indicates a worn or damaged air lock seal and should be serviced before being put back into service.
9. Tests results will be reported to the WAP Subgrantee and kept on file with DHCD. A tag will be placed on each machine tested, indicating date, test findings and DHCD staff person who tested machine. All machines will be tested at least once per year or more frequently at the discretion of DHCD.

Follow-up:

DHCD staff will assist contractors with information regarding obtaining service or purchasing new machines through manufacturers and provide information on where to find seals and gaskets to improve machine performance.

Failing machines will be re-tested as soon as possible.

Compliance is necessary before contractors are awarded additional jobs.

PRIORITY 4: COMPACT FLUORESCENT LIGHT BULBS

All compact fluorescent light bulbs must be UL approved and must be on a Massachusetts electric utility's list of approved products. All CFLs must be installed by WAP energy auditors and must be billed to the DOE WAP at the subgrantee's purchase price.

A maximum of twelve (12) bulbs may be installed in each dwelling unit weatherized. There are no minimum hours of use requirement.

INSTALLATION STANDARDS:

The installation of CFLs must comply with those of the Massachusetts electric utilities' Appliance Management Program.

PRIORITY 5: BASEMENT INSULATION

BASEMENT / CRAWLSPACE DECISION GUIDE

How to treat basement and crawlspace areas is largely dependent on the use of the area and whether or not the space is intentionally or unintentionally heated. If a heating system and/or distribution system is present in the area and there is significant heat whether by design or loss, the basement area should generally be considered a “conditioned area.”

This matrix is intended to be a decision guide. Every basement/crawlspace has different conditions and uses and WAP Auditors must use their best judgment and training in determining the most cost-effective method for treating each basement area.

Description	Intentionally Conditioned (The air temperature is near that of the living space.)	Unintentionally Conditioned (The air temperature is between that of the living space and outside.)	Unconditioned (The air temperature is near the outside temperature.)
Use of the Area	Living Space/Regularly used	Laundry/Workshop	Cellar or Crawlspace generally not used
Source of Heat	Supply registers, baseboard or radiators. Maybe simply a hole cut in a duct run.	Distribution system and/or Furnace/boiler jacket losses	No available space heat
Intended Communication with the house	Door to house may be opened or closed	Door usually closed	Door or access always closed or outside the house
Best Practices/Insulation			
Insulation: Perimeter Floor Ductwork Hydronic Pipes Steam Pipes Water Pipes	Yes, if possible No No No Generally Yes No	Depending on use of the area No Possibly Possibly Yes No	No Yes Yes Yes Yes Yes, if danger of freezing
Best Practices/Air Sealing			
Envelope Leaks	Seal leaks to the outside (making certain that sufficient combustion air is present for any appliances in that zone) and MAJOR series leaks in the floor that cannot be effectively sealed in the attic	Seal leaks to the outside (making certain that sufficient combustion air is present for any appliances in that zone) and MAJOR series leaks in the floor that cannot be effectively sealed in the attic	Seal MAJOR Leaks to both outside and the living space.
Duct Sealing	Yes	Yes	Yes
Ventilation	No	No	No unless a major moisture problem exists

FLOOR INSULATION

1. **DEFINITION:**

A material primarily designed to resist heat flow and installed between the first level conditioned area of a building and an unconditioned basement or crawl space.

2. **REQUIREMENTS:**

- A. Floor insulation must be a minimum of R-19.
- B. The insulation must always be installed with the vapor barrier facing the winter warm side.
- C. The insulation must be installed so that there is no space between the floor and the insulation. Do not compress the insulation.
- D. The insulation must be mechanically supported with “tiger paws”, wiring, twine, staples or strapping.
 - 1. Where insulation is to be installed beneath floors over crawl space:
 - a. Cover all dirt surfaces with a ground cover that acts as a vapor barrier (6 mil. polyethylene sheeting minimum).

3. **OTHER CONSIDERATIONS:**

- A. Floor insulation allows less heat loss from living areas to the basement or crawl space. A cooler crawl space or basement means a greater chance for pipes to freeze. Pipe insulation or other methods of freeze protection must always be a consideration.
- B. Floor insulation will reduce heat that may be present in a semi- conditioned basement from rising and warming the floors that result in colder floors in the living space.

PRIORITY 5a: UNINSULATED PERIMETER
(Conditioned Basement)

PERIMETER INSULATION

1. DEFINITION:

A material or assembly of materials used primarily to provide resistance to heat flow by conduction through the foundation walls.

2. PROCEDURE:

Insulate the interior of basement foundation walls with 1 1/2"- 2" vinyl backed duct wrap or faced R-11 fiberglass batts. The insulation must extend from the top of the sill box to a point at or below the exterior grade. The bottom of the duct wrap must be fastened to the foundation and all seams must be taped.

3. IMPORTANT CONSIDERATIONS:

The DHCD does not recommend perimeter insulation in all cases. When the nature of the use of the basement suggests that the insulation will remain in place on a temporary basis at best, this measure should not be attempted. Also, where high levels of moisture is a factor and cannot be effectively controlled, perimeter insulation is not recommended. In addition, since a well installed perimeter wrap may effectively air seal the foundation, consideration must be given to the availability of combustion air for any combustion appliances in the basement area and the potential role of the perimeter insulation in reducing the availability of combustion air. One of the more appropriate applications of perimeter insulation is in conditioned crawlspaces, with no moisture problems, where the entire exposed basement wall can be insulated and the perimeter wrap can be protected from ground borne moisture with a 6 mil. polyethylene ground cover.

POLYETHYLENE GROUND COVER

The 6 mil polyethylene to be installed on the ground of basement and crawlspaces must completely cover the ground area. If the polyethylene must be pieced, there should be a 2-3 foot overlapping of the pieces. The edges must be lapped up the foundation wall.

PRIORITY 6: UNINSULATED SPACE HEATING DUCTS OR PIPES

DUCT AND PIPE INSULATION

1. DEFINITIONS:

Duct Insulation: A material designed to resist heat loss off the ductwork of a forced warm air heating system.

Pipe Insulation: A material primarily designed to reduce heat loss off the surface of exposed water and steam pipes.

2. PROCEDURES:

Duct Insulation:

Seal the seams of all joints and any of those that can be shown to leak using a blower door or running the furnace fan, and repair any sections of ductwork that have become disconnected or damaged. Seal and repair both supply and return sides of the ductwork.

Ducts must be sealed with latex mastic or a butyl backed aluminized tape prior to insulating.

Wrap 1 1/2" - 2" vinyl backed duct insulation as completely as possible around the ductwork. Insulate to a minimum of R-5. Insulate only the supply side of the ductwork.

Carefully butt or overlap the ends and seams of the insulation together. All insulation seams must be thoroughly stapled to ensure a permanent seal. Duct tape is not an acceptable alternative.

Domestic Hot Water Pipe Insulation:

Be certain that hot water pipes do not leak.

If the floors above are insulated and there is no heat source in the basement, it may be necessary to insulate all the domestic water pipes.

Hydronic Space Heating Pipe Insulation:

Be certain that the pipes do not leak.

Insulate the hot water pipes to a minimum of R- 5 with a pre-formed foam or fiberglass pipe insulation rated for a temperature appropriate for hydronic heating. Tightly butt and seal all joints and miter corners to ensure a tight fit. Insulation must be the correct size for the pipe. All elbows and tees must be insulated. All pipe insulation must be kept a minimum of 3 inches from any combustion ventilation pipes.

Steam Space Heating Pipe Insulation

Insulate steam pipes with pre-formed fiberglass pipe insulation to a minimum of R-5. Tightly butt and seal all joints and miter corners to ensure a tight fit. Insulation must be

the correct size for the pipe. All elbows and tees must be insulated. All pipe wrap must be kept a minimum of 3 inches from any combustion ventilation pipes.

3. **Priorities**

Duct Insulation is to be considered a mandatory weatherization priority measure when appropriate. Duct insulation may not always be appropriate. In a conditioned basement that is deliberately warm or heated, duct insulation is not necessarily recommended. In an unintentionally conditioned basement duct insulation should be evaluated on a case by case basis keeping in mind that insulating the ductwork may contribute to colder floors.

Domestic Hot Water Insulation may be installed on hot water pipe as part of the Minor General Heat Waste Priority. In some cases, such as unconditioned crawlspaces all pipes should be insulated.

Hydronic pipe insulation is to be considered a mandatory weatherization priority measure when appropriate. In a conditioned basement that is deliberately warm or heated, pipe insulation is not always recommended.

Steam Heating Pipes is to be considered a mandatory weatherization priority measure when appropriate. Since steam system sizing is generally based on insulated pipes and the steam piping temperature loss in a cold basement can contribute to steam condensing in transit to the radiators it may be appropriate to insulate steam pipes in colder semi-conditioned basements if sufficient funds are available.

PRIORITY 7: PARTIALLY INSULATED ATTIC **(Effective R-19 or Greater)**

When existing insulation of R-19 is present, additional insulation may be installed to bring the attic insulation up to R-38 or to R-49 if it is an electrically heated unit. The attic must receive a thorough air sealing protocol, including the moving and replacing of existing insulation, prior to the installation of the additional insulation based on the protocol outlined in the Massachusetts WAP Technical Manual.

PRIORITY 8: MINOR/GENERAL HEAT WASTE, **INTERIOR STORM WINDOWS,** **MOVEABLE INSULATION SYSTEMS**

The Minor/General Heat Waste category is a list of additional measures that may be implemented upon completion of all other applicable energy conservation measures. Interior storm windows and moveable insulation systems may be considered for use for air leakage control and to increase the insulation of the existing openings.

- Electrical outlet/switch gaskets
- Low flow showerhead
- Water faucet aerators
- Domestic hot water pipe insulation

DEFINITIONS:

Interior Storm Windows or Dead Lights: A unit consisting of glazing material installed in a window opening creating an insulating air space to provide greater resistance to heat flow than the prime window alone. The interior storm window may be removable or permanently installed.

Moveable Insulation Systems :

- a. **Window Shutter** - A rigid insulating panel used to cover a window for the purpose of reducing heat loss.
- b. **Window Quilt** - Several flexible sheets of cloth or plastic (or plastic foam) attached to one another in series to form a thick, soft, flexible assembly.

PROCEDURES:

A. Interior Storm Windows or Dead Lights are to be installed on single-glazed window units that separate conditioned and unconditioned spaces. Interior storm windows must be installed consistent with the recommended priority listing. No reasonably repairable existing interior storm window may be replaced.

When a dwelling unit consists of double glazed windows, (i.e., exterior storm window and prime window or double glazed primary window) the interior type storm window should be considered as an optional

weatherization measure and placed after all other applicable measures listed in the Recommended Weatherization Priority List for the appropriate building type. Interior storms must have a demonstrated ten (10) year effective life expectancy with a solid glazing panel, rigid frame and either fixed in place or securely installed with permanent hardware.

Triple glazing of windows must be limited to electrically heated dwelling units or to those situations when the existing primary/storm window assembly or double glazed primary window is in poor condition, and any repair work on the window would either not be cost effective or would disturb lead based paint.

B. Moveable Insulation Systems may be utilized as an air sealing/insulation material in place of storm windows. Moveable Insulation Systems although effective in selective instances, can be costly, and must be properly "managed" by the residents to be effective.

C. Limitations:

Subgrantees are limited to a \$500.00 material and labor expenditure on any weatherized unit in the interior storm window category, inclusive of any associated work, such as the removal of existing storm windows.

Window quilts used as a covers for fans, air conditioners or pull down stairs must be reported on the Building Weatherization Report (BWR) as *Other Material*, not *Storm Windows*.

V. REPLACEMENT WINDOWS AND DOORS

REPLACEMENT WINDOWS

PROCEDURES AND MATERIAL STANDARDS:

Replacement Windows for all housing types (single family 1-4, multi-family 5+, and mobile homes) are to be utilized as an allowable weatherization material only after all other reasonable repair options have been considered and rejected. Replacement windows must be cost justified (except in the case of mobile homes) with a Savings to Investment Ratio (SIR) of 1 or greater using a DOE WAP approved audit (such as NEAT, REM/Rate, EA-QUIP, TREAT or SMOC-ERS) that was completed for that dwelling unit. Mobile home replacement windows are approved measure #6 on the Mobile Home Priority List and do not need to be cost-justified. All windows must, at a minimum, meet Energy Star standards for the Northern Climate Zone. Each window must be evaluated separately for replacement. Windows may not be replaced in an effort to match up all the windows in the home.

- **Installation Standards:** All window replacements must be installed to the manufacturer's specifications, with all required hardware and weather-stripping. Windows must operate smoothly and close securely with the sash locks. The window pockets must be insulated. The frame must be adequately and professionally caulked around the edges inside and out. A window screen must be included. Wood exposed to the outside must be primed or sealed. Window operation needs to be demonstrated to the occupant and manufacturer's literature and warranty left behind with property owner.

Limitations:

Subgrantees are limited to an installed cost of \$350 in DOE WAP Energy Conservation funds for the installation of the replacement window up to 101 united inches and a maximum of \$3,500 in replacement window costs per eligible dwelling unit.

Replacement windows must be reported in the *Other Material* category of the BWR.

- \$350 is the maximum allowable energy conservation cost provided that the cost is justified by the SIR of the audit. If the audit determines that a lower cost is the maximum cost effective expense for a window at that home, then the maximum cost in the audit prevails.
- Subgrantees may pay up to \$20 in energy-related *Health and Safety* expenses per window in pre-1978 homes if lead paint is present and additional installation costs are necessary to accommodate Lead RRP compliance costs involving the window. This cost is not included in the SIR.
- Additional costs for window grids are not allowable.

Other Considerations:

In those instances when the primary window is in extremely poor condition and is not repairable, but a replacement window can not be cost justified with a DOE approved audit, subgrantees may consider installing a replacement window as a *Health and Safety* measure on a limited basis. Photo documentation must be included in the client file of the condition of the existing window to be replaced. The replacement window installed must meet the same Energy Star Standards and cost maximums as above. And, in this instance, the replacement window must be reported in the *Health and Safety* category of the BWR and is included in the Health and Safety/Repair maximum of \$2,500 for that job.

Basement windows : Replacing basement windows is not an allowable energy conservation measure since there are no cost savings for replacing a window in an unheated basement area, and very limited savings even when installed in an unintentionally conditioned basement. In those circumstances when it is necessary due to Building Code concerns regarding egress and/or access, and the existing basement window is in poor condition and not repairable, subgrantees may consider the installation of a low cost window as a repair measure. In this case, Energy Star compliance is not required. The maximum allowable cost is \$200 or \$250 if the entire frame must be replaced. Basement window costs must be reported in the *Health and Safety* category of the BWR.

Sliding Glass Doors: Sliding glass doors are an allowable energy conservation measure provided the installation is cost justified in the NEAT (or other approved DOE) audit. The NEAT audit groups sliding glass doors in the same category as windows and information must be entered in building shell entry page as a window on the appropriate wall. A slider that meets the required SIR of 1 should be reported in the *Other Materials* section of the BWR. If the existing slider is in poor condition and causing major heat loss, infiltration or client access problems and the cost does not meet the SIR of 1 in the audit, the slider may be replaced using DOE WAP *Health and Safety* funds and reported in that category. The required standard is double-glazed, Low-E glass. Subgrantees are limited to a maximum installed cost of \$1,100 for a sliding glass door.

REPLACEMENT DOORS

DEFINITION:

Replacement Doors : A solid core wood or insulated steel or fiberglass hinged or sliding double glazed patio unit which is installed in an exterior door opening which separates a heated from an unheated space.

PROCEDURES:

Replacement Doors for all housing types are to be utilized only after all other reasonable repair options have been considered and rejected. All replacement doors must be reported as a *Health and Safety* measure on the BWR and included in the maximum allowable Health and Safety/Repair costs (\$2,500) for that unit. Subgrantees must document with photos the condition of the existing door that needs to be replaced

- **Installation Standards:** All door replacements must be installed to the manufacturer's specifications with all required hardware and weather-stripping. Door must operate smoothly and latch securely. Wood doors must be primed or sealed on all surfaces.
- **Price:** Subgrantees are limited to the 2010-2012 contractor prices for replacement doors.

VI. MISCELLANEOUS TOPICS

INCIDENTAL REPAIRS

Major building rehabilitation is beyond the scope of the Weatherization Assistance Program and not the intention of the program; however, WAP Energy Auditors often encounter homes in poor structural condition. Dwellings whose structural integrity is in question should be referred to a home rehabilitation related program wherever available. Weatherization services may need to be delayed until the dwelling can be made safe for crews and occupants. Incidental repairs necessary for the effective performance or preservation of weatherization materials are allowed. Examples of these include, repairing roof leaks or repairing areas of unsafe wiring to allow for the installation of attic insulation.

All incidental repair costs must be itemized and documented by the WAP contractor and reported in the appropriate category of the Building Weatherization Report. Following is a list of some of the most common repair materials utilized by WAP subgrantees:

- Lumber
- Roof and sidewall shingles
- Flashing
- Vinyl, aluminum, and clapboard siding
- Masonry supplies
- Window repair items (glass, locks, parting beads, ropes, sidestops, channels)
- Gutters and downspouts
- Paint, stain, sealers
- Electrical Inspections and wiring repairs

Incidental repairs are limited to a maximum of \$2,500 per eligible dwelling unit, inclusive of labor and materials and any Health and Safety costs. The cost of “incidental repairs” is included in the maximum cost of allowable per job expenditure.

Common Repair Measures

Interior Basement Doors. Installed to fit the opening at the base of a cellar access. Door to be built of primed or sealed 1x 6 tongue and grooved boards or pressure treated ¾ inch plywood. Must be “Z-braced” with 1x6 boards screwed to the door. Door must be hung with, at a minimum, 8” T-Hinges, weatherstripped with Q-lon or equal door kit, include a door pull/handle and two barrel bolts installed approximately 12” from the top and bottom of the door. Door to be insulated with 1” foil faced foam board (preferred) or 2” R-7 vinyl or foil covered duct wrap secured to the door with no fiberglass exposed. If door jambs or thresholds are required, they must be pressure treated or primed 2X6 lumber. Jambs must be neatly caulked or foamed where they meet the foundation.

Cut and Finish Attic/Kneewall Hatch: Frame a permanent access to the attic and/or kneewall and trim out with primed or sealed #2 Pine. Provide a removable cover of ¾” primed or sealed plywood, insulated with 3 inches of foam board or R 19 fiberglass secured to the cover. Cover to be effectively weatherstripped. Kneewall accesses may be screwed shut, at the agency’s discretion, so that the screws can be removed to gain easy access to the kneewall area for inspection.

Knob and Tube Wiring Repairs and Inspection of Repairs : See the Knob and Tube Wiring Protocol in the Health and Safety Guidance in this Manual.

HEALTH AND SAFETY MEASURES

Common Health and Safety measures include :

Kitchen and Bath Exhaust Fans : All exhaust fans installed must be Energy Star qualified with a maximum sound rating of 1.5 sones. Exhaust fans installed in bathrooms and kitchens must be designed to handle the peak moisture load of the area in which it is installed. The exhaust fan must be capable of exhausting a minimum of 70 CFM of air to the outdoors. All bath and kitchen fans must be vented to the exterior per Massachusetts code. Ventilation ducts must be sized to deliver the desired airflow at the appropriate static pressure levels. Duct runs must be kept as short and straight as possible and minimize the use of elbows and other fittings. Duct runs should be insulated where there is a danger of freezing. Avoid low spots that could create traps for condensed water. All duct runs must be terminated to the outside with a suitable cap.

Clothes Dryer Venting: Clothes dryers must be vented with rigid metal or flexible metal duct material to the outside of the building. Plastic or metallic foil products are not allowed. Ducting must be properly supported; elbows and turns should be minimized. The termination exhaust vent to the outside must be constructed of rigid metallic material. Dryer venting must be consistent with Mass 780 CMR 6501, Clothes Dryers Exhaust. Gas dryer venting must be consistent with the National Fuel Gas Code ANSI Z223.1 Chapter 10.4.4 Exhaust Ducts for Type 1 Clothes Dryers.

Carbon Monoxide Mitigation: CO problems with combustion appliances must be corrected by a utility service person or a technician licensed or certified to work on the appliance.

Gas Leak Repairs; Repairs to natural gas or propane lines must be completed by a utility serviceperson or a technician possessing a gasfitters license.

Heating System Replacements : Contributions to heating system replacements may be completed if the existing conditions endanger the health and safety of the home occupants. Heating system standards and installations must be in compliance with HEARTWAP regulations.

Lead Safe RRP Compliance in window replacements : Replacement windows installed in housing built prior to 1978 includes containment, clean-up and verification requirements to ensure compliance with Lead RRP regulations. Subgrantees may charge up to \$20 per window in *Health and Safety* costs. This cost is not part of the calculation of the SIR in an energy audit to determine cost effectiveness of the replacement window.

Primary Window Replacement: When the installation of a primary window can not be cost justified with an SIR of 1 or greater and is necessary due to the poor condition of the existing window, a replacement window may be installed as a *Health and Safety* measure.

Exterior Primary Replacement Door: When an exterior replacement door can not be cost justified with an SIR of 1 or greater and is necessary due to the poor condition of the existing door, a replacement door may be installed as a Health and Safety measure.

Additional *Health and Safety* measures will be appropriate and should be determined on a case by case basis in consultation with DHCD. Refer to the Health and Safety Guidance of the Technical Manual for an overview of the subject.

QUALITY CONTROL PROCEDURES

A comprehensive, detailed, and fully documented Quality Control procedure is a required component of the Weatherization Assistance Program. Each Subgrantee must have a Quality Control procedure that is routinely used to assess the quality and completeness of the weatherization work completed by contractors and crews. This procedure must be fully documented.

Whenever a Subgrantee weatherizes a dwelling unit, a Massachusetts WAP Certified Energy Auditor who is also an employee of the agency must inspect and approve as complete, all work invoiced by a contractor, prior to issuing payment to that contractor and submitting the job to DHCD. If there are any problems or discrepancies with the work, the Subgrantee must document the resolution of the problem, including any required follow-up inspections, prior to payment. If agency crews are used on a weatherization job, an agency staff member not associated with that crew must inspect the work and certify that the work was acceptable and all materials listed were installed as specified prior to submitting that job to DHCD as a completion.

Each Subgrantee must develop clear documentation of proper Quality Control procedures. When utilizing contractors, the Subgrantee must develop a procedure that includes a standardized Quality Control form used in conjunction with the contractor's itemized invoice. The Quality Control inspector must check off each invoiced item as complete and acceptable prior to contractor payment. All jobs must be re-measured to ensure the accuracy of the square footage. **Quality Control forms must be signed and dated by the inspector.**

If a contractor must seal off an insulation access way or uses roof or gable end vents as access to an attic area the Subgrantee must perform a visual inspection of the work prior to that area being sealed off. If the area does not receive a visual inspection prior to being closed off, the Subgrantee must return with the contractor, reopen the area, and inspect the work. The inspector must certify that the work (insulation and air sealing) is complete and installed according to specifications. This inspection must be completely documented in writing and included in the client file.

Weatherization contractors are required to notify the WAP office prior to the day that they are beginning weatherization jobs for the agency. The Subgrantee must plan to make regular, unannounced in-process inspections to determine that the WAP contractor is completing the work in an acceptable manner. These in-process inspections also offer the opportunity for the Subgrantee auditor and the contractor to discuss any problems or concerns about the job. **Subgrantees must insure that a minimum of 50% of all DOE WAP units receive a documented in-process inspection from a Certified DOE WAP Energy Auditor.** The in-process inspection must be documented in writing and does not preclude the need for a final inspection of the job after all work is completed. DHCD encourages the use of digital photography for documentation of completed work.

The final Quality Control inspection must also include Health and Safety testing consistent with the requirements outlined in the **DHCD HEALTH AND SAFETY GUIDANCE, including documentation that Lead-Safe and/or Lead RRP weatherization protocols were used by the weatherization contractor when required.**

The following Quality Control Report is intended to be a model outlining the minimum standard. Subgrantees are free to develop their own Quality Control form or package provided that all required information and documentation of Health and Safety testing is included.

POST-INSTALLATION QUALITY CONTROL REPORT

Client Name: _____ **Job #:** _____

Address: _____ **Date:** _____

Contractor: _____ **Air Sealing:** _____ **Insulation:** _____

Window: _____ **Heating System:** _____

Quality of Work

Weatherization Measure	Work Required	Work Invoiced	Good	Fair	Poor	None	Comments
Windows							
Weatherstripping							
Sash Locks							
Glass Replacement							
Window Locks							
Replacement Window							
Other							
Doors							
Weatherstripping							
Repairs							
Replacement							
Living Space							
Interior Caulking							
Other Interior Air Sealing							
Attic Air Sealing							
Top Plates							
Chimney Chase							
Plumbing Bypasses							
Other Major Bypasses							
Key Junctures							
Kneewall Transition Area							
Cantilevered Areas							
Porch Roofs							
Other Areas (List)							
Attic Insulation							
Flat Area	sq.ft.	sq.ft.					
Attic Area 2	sq.ft.	sq.ft.					
Slopes	sq.ft.	sq.ft.					
Kneewall Area	sq.ft.	sq.ft.					
Kneewall Floor	sq.ft.	sq.ft.					
Attic Accessway							
Baffles, Blocking and Damming							
Other							
Ventilation							
Gable Vents							
Roof Vents							

Weatherization Measure	Work Required	Work Invoiced	Good	Fair	Poor	None	Comments
Ridge Vent							
Soffit Vents							
Basement Area Air Sealing							
Duct Sealing							
Chimney Chase							
Major Plumbing Chases							
Perimeter Sealing							
Other							
Floor Insulation	sq.ft.	sq.ft.					
Perimeter Insulation							
Duct Insulation							
Pipe Insulation	lin.ft.	lin.ft.					
Other Repairs (List)							
Health and Safety Measures							
Sidewall Insulation							
Square Footage Insulated	sq.ft.	sq.ft.					
Scan Results							
Proper Accessing/Dense Pack							
Condition of Siding							
Storm Windows							
Deadlites							
Interior							
Repairs							
Required Permits							
Certificate of Insulation							
Heating System Work							
LEAD RRP Requirements and Compliance							

The work invoiced is certified as complete and ready for payment.

Signature of Inspector: _____ Date: _____

Follow up Required: _____ Date: _____

Call back completed: _____ Date: _____

Blower Door Test Results

Initial Test _____ CFM @ _____ Pa
 Final Test _____ CFM @ _____ Pa

Backdraft Test:

Acceptable _____ Not Acceptable _____

Final Carbon Monoxide test results :

Heating System _____ ppm
 Domestic Hot Water _____ ppm
 Kitchen Range _____ ppm
 Dryer _____ ppm
 Other Combustion Appl. _____ ppm

Combustion Appliance Zone Testing Results

Additional Comments:

GUIDELINES FOR THE WEATHERIZATION OF MULTI-FAMILY RENTAL BUILDINGS

Following is the procedure for weatherizing buildings with two or more units.

A. Buildings with less than 50% of the dwelling units eligible

When less than 50% of the dwelling units in a building are eligible for weatherization, the following procedure is mandatory:

- All applicable Major Air Sealing/General Heat Waste, Heating System, and Wall Insulation must be completed to the eligible unit.
- All common areas (hallways, attics, basements) that are immediately adjacent to the eligible unit must be weatherized.
- The building's ineligible units cannot be weatherized.
- Allowable expenditures are limited to those of the eligible unit or units and production credit will be granted for the eligible unit(s) only.

B. Building with five (5) or more units and 50-65% of the units are eligible

When buildings with five (5) or more units and 50-65% of the units are eligible for weatherization, the following procedure is mandatory:

- All applicable Major Air Sealing/General Heat Waste, Heating System and Wall Insulation measures must be performed to the eligible units.
- All common areas (hallways, attics, basements) regardless of their location in relation to the eligible unit, must be weatherized.
- The building's ineligible units cannot be weatherized.
- Allowable expenditures are limited to those of the eligible units and production credit will be granted to the eligible units only.

C. 50% of the units in a two (2) or four (4) unit building or at least 66% of the units in any building are eligible

When 50% of the units in a two (2) or four (4) unit building or at least 66% of the units in any building are eligible for weatherization the subgrantee may elect either of the following procedures:

1. The Subgrantee may elect to weatherize the entire building including all eligible, and ineligible units and all common areas. If the subgrantee elects this option, the following procedure is mandatory:
 - The entire building must be weatherized consistent with the applicable Massachusetts Weatherization Priority Measures regardless of the location of the eligible units.

- Allowable Energy Conservation expenditures are limited to a total of \$10,000 x the number of income eligible units in the building.
- Health and Safety/Repair expenditures are limited to \$2,500 x the number of income eligible dwelling units in the building.
- Total expenditures are limited to a total of \$10,000 multiplied by the number of eligible units in the building.
- A Building Weatherization Report (BWR) must be submitted for each unit completed. Costs that can be directly attributed to that unit should be reported on that unit's BWR (i.e. costs associated with Air Sealing/General Heat Waste or wall insulation for that unit). Costs associated with common areas in the building can be charged off to the adjacent unit or divided among the units in such a manner that will ensure that the building receives maximum weatherization services. **Ineligible units must be identified in the appropriate category on the BWR.**
- Subgrantees must ensure that the regulatory maximums for Energy Conservation and Repair/Health and Safety are not exceeded on any individual BWR.

Production credit will be granted for each ineligible unit weatherized with a minimum \$500 expenditure.

2. The Subgrantee may elect to weatherize only the eligible unit or units and common areas in the building. If the Subgrantee elects this option, the following procedure is mandatory:
 - All applicable Major Air Sealing/General Heat Waste, Heating System, and Wall Insulation must be completed to the eligible unit(s).
 - All common areas (hallways, attics, basements) regardless of their location, must be weatherized.
 - The building's ineligible units cannot be weatherized.
 - Allowable expenditures are limited to those of the eligible unit or units and production credit will be granted for the eligible unit(s) only.

The Guidelines for the Weatherization of Multifamily Rental Buildings apply only to buildings where a minimum of one dwelling unit is occupied by a tenant. Privately owned condominiums and cooperatively owned buildings may not receive assistance under these Guidelines (including provisions for weatherizing income ineligible units) unless one or more units is occupied by a tenant. These privately owned units may receive assistance on an individual basis, based on the eligibility status of the owner.

D. Weatherization of Vacant Units

A vacant unit must always be weatherized as an ineligible unit. Vacant units **cannot** be weatherized using LIHEAP Funds. The only case in which a vacant unit may be weatherized as an eligible unit is when the building is being rehabilitated under a local, state, or federally funded rehabilitation program in conjunction with CDWAP. Weatherizing these units requires DHCD prior approval under the Special Projects Guidance in all instances.

Subgrantees may not sign “Vacant Unit” agreements with building owners on the promise that the units will be occupied by eligible tenants outside of the CDWAP process.

E. Multifamily Dwelling Client Prioritization Policy

DHCD will waive the mandatory client priority requirements in those cases in which the weatherization of an entire building is possible, and at least one dwelling unit in that building is classified as a priority client. In these cases, the cost effectiveness of the whole house approach will take precedence over the priority status of the remaining units in the building. This waiver does not apply to any income ineligible units in the building.

BUILDING WEATHERIZATION REPORT (BWR) COST SECTION MATERIAL BREAKDOWN

(Effective Date: January 1, 2011)

Weatherization measures completed must be itemized and reported in appropriate costs section on the BWR as itemized below:

1. Weatherstripping and Sealants

Door and Window Weatherstripping
Electrical Outlet Gaskets
Caulking and Sealing Material
Glazing Compound/Putty
Duct Sealing Materials (mastic/butyl backed tape)
Spray-type Foams, single and two part
Materials that have a Primary Function of Air Sealing, (i.e. Pieces of Foam Board, Metal Flashing used to seal a chimney chase)

2. Insulation

Fiberglass Batt and Blanket, Blown
Cellulose
Rigid Foam Board
Icynene
Pipe and Duct Wrap
Attic Hatch and Pull-Down Stairway Insulation

3. Storm Windows

Deadlites
Interior Storm Windows
Moveable Insulation Systems for Windows

4. Heating System

Primary Space Heating System
Combustion Chambers
Replacement Oil and Gas Power Burners
Clean Tune and Evaluate Materials
Thermostats, Standard and Clock
Hydronic Boiler Controls
Thermostatic Radiator Valves
Air Ducts and Connectors

5. Other Materials

Window Sash
Insulation Guards
Vapor Barriers
Replacement Windows (SIR equal to or greater than 1)
Ventilation Devices (i.e. roof, gable or soffit vents)
Replacement Sliding Glass Doors (SIR equal to or greater than 1)
Low Flow Showerheads/Flow Restrictors/Faucet Aerators
Water Pipe Heater Strips
Compact Fluorescent Lighting
Window Quilts used to cover fans, air conditioners and pull-down attic stairways.

6. Repairs

Glass/Parting Beads/Side Stops
Window Locks, Ropes, and Channels
Glazing Points
Window and Door Trim
Nails/Screws/Brads/Other Fasteners
Glue/Adhesives
Flashing (except to air seal chimney chase)
Lumber/Shingles/Siding
Masonry Supplies, Bricks, Blocks, Mortar
Paint/Stain/Sealers
Sheetrock/Plaster
Gutters/Downspouts
Mobile Home Roof Sealants and Skirting
Repairs to the Primary Heating System
Electrical Wiring, Fuses, Boxes, and Inspections
Building Permits

7. Health and Safety

Gas Leak Repairs
Carbon Monoxide Mitigation
Bathroom/Kitchen Exhaust Fans and Vents
Dryer Vents
Heating Systems when appropriate
Required Moisture Mitigation Measures
Replacement Windows (SIR less than 1)
Replacement Windows in unheated spaces (i.e. basements)
Replacement Doors (SIR less than 1)